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FOURTEENTH REPORT

OF THE

STATE ENTOMOLOGIST

ON THE

NOXIOUS AND BENEFICIAL INSECTS

OF THE

STATE OF ILLINOIS.

Third Annual Report of S. A. Forbes,
For the year 1884.

SPRINGFIELD, ILL.:
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1885

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LETTER OF TRANSMITTAL.

ILLINOIS INDUSTRIAL UNIVERSITY,
OFFICE OF STATE ENTOMOLOGIST.
CHAMPAIGN, ILL., December 31, 1884.

To his Excellency, JOHN M. HAMILTON, *Governor of the State of Illinois:*

SIR: I have the honor to transmit herewith my third report as State Entomologist of Illinois, covering the operations of the office for the year 1884.

Besides the articles presented in the report proper, I have prepared an elaborate paper on certain contagious diseases of insects, and on numerous studies and experiments made at the office for the cultivation of the virus of such diseases and their propagation by artificial measures. This study has not yet reached the stage of actual successful application in the field on a large scale, and I have therefore decided to withhold the results, for the present, from publication here, and to publish them instead as a contribution to science in the Bulletins of the State Laboratory of Natural History. The space thus saved I have decided to use for an index to the first twelve reports of the State Entomologists of Illinois; and this is presented herewith as an appendix to my present report.

Respectfully submitted,

S. A. FORBES, *State Entomologist.*

INTRODUCTION.

ENTOMOLOGICAL CALENDAR.*

To the year 1884 we can not accord any peculiar distinction in the annals of economic entomology in Illinois, unless we consider the general prevalence of the SOFT MAPLE BARK LOUSE (*Pulvinaria innumerabilis*) and a notable outbreak of the GRASS WORM (*Laphygma frugiperda*) as especially remarkable events. The general damage to the crops by insects, was, as a whole, decidedly below the average, not a single one of the great scourges of agriculture having attracted general attention or done conspicuous damage except in one or two instances and in limited localities. I wish I might believe that this fact was due in any considerable measure to the progress of the popular knowledge of economic entomology and to an increased disposition to apply its resources to the war against our insect enemies, but I judge that it is to be attributed to providential rather than to human interposition.

The average weather of this season and the preceding, inclining in both to extraordinary moisture, except during the period when the Hessian fly is peculiarly subject to injury by drouth, has supplied conditions on the whole unfavorable to a high rate of multiplication among those species peculiarly susceptible to meteorological influences.

The HESSIAN FLY, so destructive last year throughout Southern Illinois, was so far decimated by its parasites and by the long drouth and heat of summer, that we have not encountered it in destructive numbers except in Clark county, in Eastern Illinois, in localities where it did not last year prevail. The fact that the fly occurred here when the weather was not different from that of more southerly localities infected last year, shows that we owe the arrest of its ravages in these localities less to the weather than to other causes,—chief of which are, of course, its parasites.

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*Under the above head it is proposed to give, each year, a summary of the principal events of interest in the field of economic entomology within the State, with principal reference to the great insect pests whose numbers vary widely from year to year, so that these introductions may afford a continuous history of the oscillations of the most important species. Here also will be introduced those species first recognized as injurious to agriculture during the year which the report covers, where these seem of sufficient importance to deserve special mention in this connection.

The CHINCH BUG was not heard of from farmers anywhere in the State, nor found unusually abundant by us in our field observations. As a contribution to the life history of the species in "off years," the following memoranda for 1883 and 1884, are worthy of record. During the former year we first noted the chinch bug on the 14th of March, in Central Illinois. The adults were still in their winter quarters, occurring about roots in matted grass under old boards and rubbish. April 10, in Southern Illinois, they were still found in the rubbish of strawberry fields, and occasionally among dead leaves in the woods. On the 20th of that month, a very few were encountered in wheat fields near Carbondale. On the 26th, at Normal, they were still collected by the hundred, under boards, not having yet emerged from their winter quarters in Central Illinois. Indeed, on the 7th of the following month, we found them there in the same situation, and in rubbish about wild strawberry plants. On the 20th May, at Centralia, I saw a few adults in wheat fields, and on the 24th, at Decatur, they were relatively abundant in wheat at the bases of the plants, many of them coupled.

Specimens placed alive in an empty vial soon deposited their eggs, but careful search about the roots of the plants failed to discover any, and it is probable that oviposition was but just beginning. On the 6th June, adults were found quite numerous just beneath the surface of the ground, about young corn in the field. Many of these were pairing and laying their eggs about the roots. On the 19th June, young chinch bugs emerged from eggs deposited the 23d of the preceding month. On the 23d June, we found the adults, still pairing, in corn fields, and young individuals very numerous between the sheath of the lower leaf and the stalk. On the 26th, at Warsaw, the adults were still to be seen among the roots of wheat, together with many young in the first stage. A few chinch bug eggs were also found in the same situation; and adults still occurred at this season among the roots of corn. On the 29th, at Godfrey, Illinois, a few miles above St. Louis, young chinch bugs were noted frequently in wheat fields, mostly in the first stage, (that immediately following the egg), but a few in the second. Adults were also still occasionally to be found. On the 2d July, the young were noted as still occurring beneath the sheaths of corn, none having yet emerged to the outer surface. All the stages were now found in wheat fields, although pupæ were relatively rare. On the 25th July, in Northern Illinois, young were found beneath the sheaths of the leaves of corn, mostly in the second stage. From this time to October 1, a hiatus occurs in our observations for 1883, but at the latter date all sizes still occurred upon the corn, concealed beneath the bases of the leaves, ranging in age from adults to those newly hatched. On the 11th November, both imagos and pupæ were found hibernating under the bark of an old log at Normal.

In 1884, considerable numbers were found March 24, under boards at Normal, scattered under leaves and rubbish in woods, and in similar situations. They were apparently less numerous than even the year before. April 14, adults were seen under boards and rubbish in Southern Illinois. May 9 and 10, they were occasionally obtained by sweeping grass, having evidently now emerged from

their winter quarters. On the 16th, adults were noticed at the bases of the plants in rye fields, (doubtless engaged in laying their eggs), and also at the bases of the stalks of sprouting corn. On the 19th, at Danville, they were likewise seen at the bases of stalks of wheat, and were taken by sweeping the meadows. In the former situation they were several times observed *in coitu*. On the 22d, considerable numbers, all adult, were obtained from rye. No young could be detected, although the adults were frequently paired. The latter were also occasionally numerous in corn fields. On the 24th, they were taken frequently by sweeping oats, and likewise found coupled about the roots of corn. On the 5th July, the young were noted frequently at bases of stalks of rye in fields at Normal, and on the 20th, were seen occasionally on corn beneath the sheaths. August 4 to 11, adults and pupæ were frequently taken on corn, and on the 21st, both adults and young of several stages, some, evidently of the first, occurred at Effingham in fields of corn between the leaves and stalk. September 25th, at Godfrey, adults were found seemingly preparing to hibernate under rubbish in the strawberry fields. Imagos, with occasional pupæ, were likewise found between the husks of ears of corn.

From the above we may infer the usual existence of two broods and at least the occasional occurrence of a third, even in those seasons when the results of their multiplication are relatively insignificant, and the insects themselves escape general notice. Their life history in time of peace hence does not differ materially from that during seasons of immense and wide-extended ravage.

The ARMY WORM was not heard from anywhere as a notably injurious species, although occasional individuals were noticed in the corn, as usual, in the course of our field operations. A fresh female moth was noticed May 3, having evidently just emerged from the chrysalis. On the 27th May, mature larvæ were found feeding upon leaves of wheat in the field. Transferred to a breeding cage, these entered the earth June 7, one emerging June 28, and the other July 7.

The CORN ROOT WORM (*Diabrotica longicornis*), has continued its injuries to the staple crop of the State, interrupted only by the growing disposition to practice rotation of crops as a remedy against it. All the information acquired during the last year is in the line of that previously published, no case of considerable injury having been observed by us or reported to me upon ground not recently in corn for two or more years.

Our collections and observations also confirm the previous account of its life history as published in my first report. The earliest date of the appearance of the larvæ in the earth, which we have ourselves noticed, is June 14, (1883). I found the larvæ about half grown in fields of corn near Polo, in Ogle county.

During the summer just past, less injury was done to corn than in some previous seasons, owing to the wetness of the weather in early summer, in consequence of which the affected corn rooted more firmly and was able to maintain itself notwithstanding the

attacks of the insects. Indeed, during July, I found many roots of corn burrowed lengthwise by nearly full-grown larvæ, but nevertheless not killed by this violence.

The adult was first seen by us this year, July 21, at which time pupæ and full-grown larvæ, together with others not matured, were abundant in the earth. Eggs were again found in the earth about standing corn stalks in October of this year, dead adults occurring at the same time under leaves and in the ground.

The damage inflicted by this insect has in some cases within my observation amounted during the last year to a nearly total loss of the crop, one farmer reporting a rapid falling off in the yield from sixty bushels to six per acre, owing evidently to the ravages of this insect only.

In extreme Northern Illinois, I detected, in July, the notorious WHEAT MIDGE, (probably the most destructive of wheat insects), in fields of spring wheat then just ready for harvest. Considerable damage had been done to here and there a field in that vicinity. The importance of a general knowledge of the characters and habits of this most destructive pest is so great, that I have prepared a brief synopsis of the essential facts relating to it for this Report.

In autumn, in fields of fall wheat, occurred a sudden irruption of a caterpillar which had not attracted attention in Illinois for more than a dozen years. This species, almost universally mistaken by farmers for the army worm, was the GRASS WORM, (*Laphygma frugiperda*), sometimes called also the fall army worm. It ate to the ground large tracts of winter wheat, and where these areas were not resown, the ground still remains bare. The larvæ went into the earth in October, and most of them are passing the winter in the pupa stage.

The WHEAT STRAW WORM (*Isosoma tritici*) still remains a growing evil where winter wheat is raised, and an additional species of very similar habit, called the GREATER WHEAT STRAW WORM (*Isosoma grande*), was discovered by us this year in Central and Eastern Illinois.

The WHEAT BULB WORM, an outbreak of which occurred two years ago in Fulton county, has not been found seriously injurious since, except in a field of rye this fall, in central McLean county. This grain was sown in July as pasture for stock,—a fact which confirms my former supposition with respect to the injurious effect of early sowing, where injury by this insect is to be anticipated.

A new enemy to corn (the ROOT WEB WORM) which I first detected last year, was not bred to the imago until the present season. In abundance where occurring, and magnitude of its injuries, it promises to become one of the most important pests of the corn grower. An article upon this insect is published upon another page.

The IMPORTED CABBAGE WORM (*Pieris rapæ*), although still notably injurious, has been clearly less so this year than for several years preceding, owing unmistakably to the general prevalence and extreme destructiveness of the cabbage-worm disease mentioned in the intro-

duction to my report for last year. In several cabbage fields in Central Illinois, I saw, in August and September, the work of this larva arrested and the insect itself almost exterminated by an outbreak of this disease.

An epidemic extremely similar to the above, possibly identical with it, and not impossibly derived directly from it, has prevailed extensively during the season among the SILK WORMS of Illinois, having, for instance, almost completely destroyed a lot of these worms at the Industrial University which were being reared for experimental purposes. I have this season successfully cultivated the virus of this disease and applied it to the destruction of other insects.

The FOREST TENT CATERPILLAR, an outbreak of which species occurred last year in Southern Illinois, was again seen in the same region this season, but in number so greatly reduced as to inflict little if any definite injury. The condition and fate of examples collected by us in Southern Illinois this year and kept in breeding cages until they perished, confirmed my supposition of a destructive contagious disease among them, apparently the principal cause of their disappearance last year. This was one of the diseases known as *muscardine*, similar to that of the silk worm occasioned by the well-known fungus *Botrytis bassiana*.

Probably the most notable entomological event of the year was the extraordinary abundance of the MAPLE BARK LOUSE (*Pulvinaria innumerabilis*), which species occurred in destructive numbers throughout the State, at least from Chicago to Shelbyville, and probably also farther south. Notes upon the life history, and details of experiments upon this species with insecticides, will be found upon another page.

The CHERRY SLUG (*Selandria cerasi*) continued abundant this year, extending its ravages farther to the south than the year before. It was extremely abundant in Central Illinois, at least as far south as Bloomington, many trees being nearly defoliated by it.

The APPLE LEAF SKELETONIZER (*Pempelia hammondi*) and the LESSER APPLE LEAF ROLLER (*Teras malivorana*) were each more abundant, locally, in Central Illinois, than the year before, and continued their injuries in nurseries until a later date, in some cases almost wholly preventing advance in growth of young nursery stock.

The GRAPE POMACE FLY, the larvæ of which abound everywhere in rotten apples and in old pomace at the cider mills, was this year reported as extremely injurious to grapes in Western Illinois. Another grape pest, well known in Europe, but not hitherto reported in America, (the GRAPE PHYTOPTUS), was discovered by us this season in Illinois, infesting certain of the native varieties. The GRAPE PHYLLOXERA, concerning whose status in Illinois I have received this season several inquiries from foreign consuls, has maintained about its usual average during the present year, doing occasional damage to those varieties especially susceptible to it, but producing little or no effect upon the total yield of the vineyards of the State.

THE TARNISHED PLANT BUG, whose work in strawberry fields attracted especial attention last year, and led to the publication of an elaborate article in my last Report, has continued about as before. Its injuries in strawberry fields were, however, decidedly less conspicuous, owing to the more favorable character of the season. The STRAWBERRY ROOT WORMS and the CROWN BORER were seemingly neither more nor less abundant than usual.

I.

Contributions to Agricultural Entomology.

ARTICLE I. ON NEW AND LITTLE KNOWN CORN INSECTS.

In arranging for this report, our notes of the season on insects injurious to corn, I have assumed that in the present state of our knowledge, nothing could be reckoned really insignificant which either now affected or threatened to affect in future, a crop so important as this to the prosperity of the State. The balance of insect life in any cultivated region, is so unstable in character, subject to changes dependent upon differences of season and agricultural practice, and upon a variety of other causes not well understood, that it is possible that the most trivial species affecting a crop, may rapidly rise to be one of the most destructive, especially if it be its normal habit to produce several successive broods in a season. In such an event the importance of accurate knowledge of the uprising species will be readily appreciated, and our acquaintance with the life history of all should be such that we may be able readily and correctly to divide them into the groups of dangerous and indifferent species. Our observations of the year, have consequently not been confined exclusively to the major insects injurious to corn, but have covered the minor species also, with a view to thus laying the foundations for a complete knowledge of the subject of insect injuries to this crop in Illinois; and the following paper is to be regarded as preliminary to an elaborate and extensive treatment of the subject in a future report.

1. The Root Web Worm.

(*Crambus zeëllus*, Fernald.)

Order Lepidoptera. Family Crambidæ.

(Plate I. Figs. 1-3.)

The discovery of an insect new both to science and to agricultural entomology, and capable of serious injury to the most important crop of the State of Illinois, is, fortunately, at this date an unusual event, so thoroughly, of late years, has the ground been scanned; and yet, long as is the list of insect enemies of Indian corn, we have no reason to suppose that it is yet complete.

The balance of animal life is continually shifting, even in old and long-settled countries, species formerly rare or unknown coming to the front, and others formerly abundant and perhaps destructive, retiring temporarily from view. Not only do insects of other regions invade our own territory, but a peculiar collocation of circumstances often favors the undue multiplication of some one or more of our native species, with the result to convert an insect harmless from its rarity, into a very serious obstacle to the success of agriculture; and it is to be noted that having once reached this dangerous prominence, it is a rare thing for an insect to permanently lose its hold on the agricultural products of the country.

In respect to the species treated in this article, we may at least congratulate ourselves that it has been detected early in its career, before it has reached really dangerous numbers, and prompt and thorough study of its economy and of its life history may give us the means of controlling it before it can do serious mischief.

On the 7th June, 1883, my assistant, Mr. Webster, who had been detailed to study the work of the black-headed grass maggot in corn fields*, brought to the office some supposed cutworms—bristly reddish larvæ, which he had found gnawing the roots of corn below the surface, in fields in McLean county, on both old and new ground.

They were not seen again during this season, but on the 19th May of the present year I received the same species from Mr. E. A. Gastman, superintendent of public schools at Decatur, with the

* See 13th Report of the State Entomologist of Illinois, pp. 57-59.

information that they had been sent him from Harristown by a farmer, who reported that they were doing serious damage to the roots of his young corn. On the 22d of that month they were again sent me, by Mr. R. H. Mills, of Dwight, in Livingston county, with the following note:

"My corn is being badly damaged by small worms. I send you specimens of them, all of which were found in one hill. There are usually not more than three or four in a hill. The corn is large enough so that we are cultivating it. I shall be very glad if you can give me some information in regard to the worms. They are making bad work with the corn in our fields."

On the 23d, Mr. D. C. Tomlinson, of Osco, Henry county, sent me other specimens of the same species, from a field of corn on clover and timothy sod, which had been plowed up early in April. His whole field had been so completely destroyed by this larva, in conjunction with two species of cutworms, as to necessitate replanting. He found the new larvæ (now three-eighths to seven-eighths of an inch long,) partly or wholly encased in a web within the ground.

On the 27th May, I visited Dwight for the purpose of searching the fields of Mr. Mills from which the web worms had been sent me. The corn in this field was injured most in patches. Over one area of about one-fourth of an acre, many hills were missing, and fully one-third of those remaining were damaged, with a plant occasionally killed. Upon digging into the affected hills, the caterpillars were found just beneath the surface, sometimes as many as five or six in a hill, each in a retreat formed by loosely webbing together a mass of dirt irregularly cylindrical in shape, one and one-half to two inches long, and about one-half an inch in diameter. The worm was found in a silk-lined tube within this mass (the tube not always perfectly constructed), which in some cases opened at the surface, its presence being indicated by a circular opening about the size of wheat straw, in the earth next a stalk of corn.

The first attack upon the plant was made by gnawing the outer surface beneath the ground and above the roots. Occasionally the stalk was completely severed, as by a cutworm, but usually not, the larvæ showing rather a disposition to work upwards, eating a superficial furrow or burrowing lengthwise along the center of the stem. In other parts of the field, only here and there a stalk was attacked. The foliage was also frequently eaten, the lower leaf first and then the upper ones, the larva evidently leaving its burrow for this purpose. The tips of the leaves were eaten off, or irregular elongate holes were eaten through them,—probably at night, as I have never seen the larva abroad by day. Where the corn was largest, webbed masses of dirt were frequently found which contained no larvæ, a fact which I was at first inclined to suppose indicated that the insect inhabiting them had transformed, especially as the larvæ found were of quite uniform size and apparently full grown. I failed to find a single pupa, however; and as our breeding experiments did not yield the insect for more than a month, it seems more likely that these empty webs had been abandoned by worms which had gone in search of younger stalks.

On the 7th June, after several hours of careful search in cornfields near Lexington, McLean county, where I selected by preference the least thrifty fields, I found no living larvæ, and but a single mass of webbed dirt at the base of a stalk precisely similar to those formed by the web worm, the hill containing it having been evidently damaged some time before.

A number of the larvæ were brought to the office and placed in earth in a breeding cage on the 28th May. On the 14th June those in the breeding cage were transferred to fresh corn. Many of them were dead, but nine active specimens remained. On the 30th the corn was renewed and another search was made. No larvæ were found and but two living pupæ. A single imperfect moth was released from the earth in which it had completed its transformations, but it was not able to expand its wings and could not be determined. One of the other pupæ was unfortunately crushed by accident, and the other was badly infested by mites which clung closely to its crust about the head with inserted beaks. These were carefully picked away, and this sole remaining pupa was returned to thoroughly calcined earth to complete its transformations. On the 22d July it emerged as a small gray moth, evidently belonging to the family Pyralidæ.

From Prof. C. H. Fernald, to whom I referred the specimen, I learned that it was a species of Crambus new to him and probably undescribed. On the 3d July Mr. Mills, of Dwight, wrote me that the larvæ had almost entirely disappeared from the corn fields, and that the season had been so favorable to the crop that no perceptible damage had finally resulted, with the exception of the loss of a few hills here and there.

DESCRIPTION.

Larva.—The presence of this larva in the earth may be suspected when an irregular mass of webbed dirt is found among the roots of the corn, an inch or less beneath the surface. If this mass be picked open, the larvæ will usually be found safely ensconced within.

The individual web worm is characterized by its pale reddish brown color, nearly black head, dusky yellow neck or cervical shield, and by the extraordinarily large "piliferous tubercles," each bearing an unusually long black hair. These "tubercles" are not elevated, but consist of smooth shining areas, of a firmer consistency and a darker tint than the adjacent surface.

The head is dark chocolate brown, slightly and irregularly rugose, and bears scattered long hairs of a yellowish color. Upon the front is an S-shaped white mark which does not coincide with the sutures of this region, the branches of the S lying some distance outside the corresponding sutures, and the common stem being relatively short. The cervical shield is yellowish, with a white median line, a whitish anterior edge, and an oval black spot on the sides near the middle of the lateral margin. Surface with a few scattered long dark hairs. Below the lateral edges of the cervical shield, are two large piliferous tubercles with the anterior spiracle situated in an emargination at the upper posterior angle. The second and third

segments of the thorax each bear two rows of piliferous tubercles,—the anterior of four large quadrate spaces, the posterior of two, sometimes united on the middle line.

From the fourth to the tenth segment, the piliferous tubercles above the spiracles are in two transverse rows of four each, those of the anterior row being quadrate with rounded angles, and at least as large as the interspaces between them, and those of the posterior row transversely elongated, about twice as long as wide. The lateral tubercle of the anterior row immediately above the spiracle is emarginate at its posterior inferior angle, on all the segments from the sixth to the ninth. On these segments is a smaller tubercle, immediately behind and beneath the spiracle, and two additional ones occur between the spiracle and the proleg. Directly before and without each proleg, is a narrow arcuate tubercle, bearing several long hairs. The hairs upon the dorsal tubercles are at least as long as the corresponding segments of the body.

The anal shield is smooth, of the same dark reddish brown color as the piliferous tubercles, and bears a few long brown hairs. The spiracles are all dark brown, the anterior the larger, and the two posterior next in size. The ventral surface is a little paler than the dorsal, the prolegs have a yellowish tinge, the thoracic legs are dusky.

Length of a full-grown specimen .6 to .8 of an inch, its greatest width .1 inch.

Pupa.—The pupa is smooth, shining, pale brown, the abdomen a little darker, without hairs or spines. Eyes reddish brown, bilobed above; abdomen with an obtuse horny tip.

Length .4 inch, breadth .1 inch.

Imago.—Prof. Fernald, whom I requested to prepare a description of the moth, kindly furnished me the following, in advance of its proposed publication in the *Canadian Entomologist:* *

CRAMBUS ZEELLUS, n. s. Fernald.

"Expanse of wings, from 18 to 24 mm.

Palpi, head and thorax, pale leaden gray. The labial palpi extend forward as far as the length of the head and thorax. The maxillary palpi are as long as the head.

Fore wings, dull leaden gray, mixed with ashy and whitish, especially on the outer part, and crossed beyond the middle by two angulated dull ochre yellowish lines, overlaid more or less with dark brown. The first line crosses the end of the cell where it is angulated. The second crosses the wing about half way between this last and the end. The terminal line is dark brown, and a dark brownish cloud extends obliquely in from the apex to the second line, but does not reach the costa. A narrow ochre-yellow line, somewhat curved, extends from the middle of the base of the wing to the second line near the anal angle, and a similar line, though less plainly marked, runs parallel, between this line and the

*Since published in Vol. XVII, 55, March, 1885.

hinder margin. The terminal space is more or less gray. Outer margin regularly excavated below the apex. Fringes pale metallic lead color. Hind wings, pale fuscous with lighter fringes. Under side of the body and all the wings, pale fuscous.

Habitat:—Maine, Pennsylvania, West Virginia, Illinois, Missouri."

DISTRIBUTION.

From the observations here recorded, it is rendered probable that this species is distributed generally throughout Central Illinois at least, having been actually received by us from Henry, Macon, McLean, and Livingston counties.

LIFE HISTORY.

The small size of the individuals observed earliest in the season perhaps makes it possible that they came from the egg last spring; and the brood represented in our collections must have completed its development by the end of July. Whether a second brood appears is altogether uncertain.

The injuries inflicted occur so early as to permit replanting in most seasons in case they should prove to be of serious import; and this species is consequently to be classed with the cutworms so far as the effect of its injuries to corn are concerned.

NATURAL ENEMIES.

With the exception of the mites which attack the living pupæ in our breeding cages, and which were probably responsible at least in part for the death of most of the larvæ which we tried to rear, the only natural enemy of this species observed by us was a common predaceous ground beetle, *Pterostichus sayi*, of which there were numerous examples in an infested field near Dwight. The crop of one of these contained a black fluid and no solid structures, (an indication that the beetle had recently drained some insect of its juices), and the other was full of fragments of a dark, thin-skinned caterpillar with but few hairs. This was probably a web worm, as these beetles had been noticed, by the owner of the field, abundant in badly injured hills infested by those insects.

ARTIFICIAL REMEDIES.

Respecting artificial remedies, I can at present make only a few suggestions. When corn is replanted on account of the ravages of this web worm, the second planting is liable to be attacked and destroyed in turn, since the larval life of the brood lasts too long to permit a postponement of the replanting until the injuries of the insect are arrested by pupation. As the larvæ are all collected in the old corn hills, it is clearly inexpedient that this corn be plowed up until the cultivation of the field positively requires that this should be done. As long as it is left for the larvæ to feed on, they are little likely to desert it for the new planting, and they may even remain feeding on it until their active larval life is practically completed and their season's mischief finished.

Indeed it is much to be desired that some rapid and easy mode of applying some cheap insecticide to these larvæ in the ground may be invented, since where their injury is sufficient to compel replanting, every worm in the field could be destroyed by the application of a little kerosene or Paris green to the old hills of corn.* Where the injury is not total it is easy to capture the worms by hand without injury to the corn. As they lie secured by day in the ground just beneath the surface immediately beside the corn, they may be turned out of the earth by a motion of the finger,—the webbed nest always serving to show their position. I do not doubt that the labor of boys could very profitably be utilized in this way, even in large fields of corn.

2. The Sulphur Leaf Roller.

(*Dichelia sulphureana*, Clemens.)

Order Lepidoptera. Family Tortricidæ.

[Plate I. Fig. 4.]

The injuries to agriculture due to this species have been hitherto insignificant in Illinois, as far as my observation extends, but as they have attracted sufficient attention in other parts of the country to warrant treatment in the reports of the United States Entomologist, and as I have found that they affect, to some extent, by far the most important crop in Illinois, brief notice of them is evidently desirable.

LITERATURE.

This species was first described by Clemens in 1860, in the Proceedings of the Philadelphia Academy of Sciences for that year, page 353, as *Crœsia? sulfureana*. In 1864 it was again described by the same author in the Proceedings of the Entomological Society of Philadelphia, under these additional names: *Crœsia? fulvoroseana*, *Crœsia? virginiana*, and *Crœsia? gallivorana*, the form described under the latter name having been received from Illinois.

A more general description, including all under one specific name, together with notes on distribution, is given by Robinson in the Transactions of the American Entomological Society for 1869, (Vol. II, p. 273).

In the Report of Prof. Comstock for 1881, as United States Entomologist, was published the only elaborate article upon this species which has yet appeared, he treating it especially as a clover insect, describing the larva and pupa, giving an account of its life history as indicated by his observations and breeding experiments, and summarizing the facts known respecting its distribution.

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* Both the above considerations apply also to the wire worms in corn, since these are likewise gathered wholly in the corn hills in infested fields.

By Prof. Packard, in 1882, in the second volume of Papilio, page 182, the larva was re-described, the occurrence of the insect in Maine was noted, and observations were added upon its food plants and the date of its transformations.

In the same year, Prof. Fernald mentions the species in his list of North American Tortricidæ, and gives its synonomy, distribution, and choice of food plants.

In 1883, Mr. Coquillet, of Illinois, described the larva again, and gave some additional notes upon its food plants and life history.

DESCRIPTION.

Imago.—This insect may be described in general terms as a brownish yellow moth, the fore wings of which are marked by two V-shaped brown bands (the apex of the angle backwards) so placed that when the wings are closed these markings form an X.

The palpi are long, nearly or quite twice the length of the head, yellow above, deep red laterally and beneath. The antennæ are reddish brown; the head and thorax are yellow above, tinged with red or purple at the sides; the patagia red in front, yellow beyond. Anterior wings golden yellow, finely reticulated with red or purplish, (sometimes the reticulations are wanting), costa tinged with purple at base. A purple spot on the middle of internal margin throws out two diverging lines, one of which attains the costa at the basal third, the other ending just below a similarly colored subapical costal spot. The internal margins more or less tinged with purple, somewhat constant and deepest towards the base; fringes yellow. Posterior wings above and beneath varying from pale yellowish fuscous to dark fuscous or blackish. Under surface of anterior wings clouded centrally with fuscous; the margins paler, sometimes yellow. Abdomen brownish, legs pale silvery brown, anterior ones darkest. Expanse, female, 14–17 mm.; female, 17–19 mm.

Larva.—Cylindrical, slightly fusiform, 14–15 m.m. long. Head and cervical shield varying from pale honey-yellow to yellowish brown, the rest of the body yellowish green, translucent, showing the darker green of the alimentary canal. Eyes, third joint of antennæ and tarsi blackish. Piliferous tubercles (slightly paler than the rest of the body) on each segment, arranged in a trapezoid, each bearing a brownish hair half as long as the body is thick. Spiracles green, ringed with brown. At the end of the supra-anal is a flattened spinose tubercle.

Pupa.—The pupa is thus described by Prof. Comstock in the Report of the Department of Agriculture for 1880:

"Length, 8 m.m. Color, dark shining brown, lighter at the end of the wing covers and the parts covering the palpi and base of the antennæ. Front rounded and smooth. Abdominal segments on the dorsal side armed with two transverse rows of small spines inclined backward, those on the posterior edge of each segment finer and closer than those of the other row. Abdomen terminated by a protuberance, flattened above, rounded at the end, hollowed out underneath the base, and armed with two fine hooks on each side, and four from the end."

This species has a wide range, occurring throughout the country from Maine and Massachusetts to Illinois and Missouri, and Florida and Texas.

LIFE HISTORY.

Prof. Comstock believes this leaf-roller to be at least three-brooded, the larvæ of the first brood occurring in May, of the second, in June, and of the third, in August.

Larvæ collected by him May 13 pupated in part on the 19th and emerged as moths from the 19th of May to the 3d of June. Those collected June 20 pupated July 1 and emerged July 5-14; and those taken August 15 pupated September 1 and emerged September 1-16. Later larvæ were found October 21.

In Maine, larvæ collected by Packard the first week in August pupated August 7 and transformed to the imago August 16 and 17.

In Illinois there seem also to be several broods, as indicated by the following facts from our breeding-cage records, but it is not possible to fix their number or to assign them limitations of time.

Larvæ collected May 17, this year, began to pupate on the 30th and to emerge June 7. Those obtained May 23 pupated June 11-21 and commenced to emerge June 19. Others taken June 7 emerged June 26-28. Those pupating July 6 emerged July 11, (Coquillet), and those taken August 18 pupated on the 20th and completed their transformations on the 31st of the same month.

Hence, without actually breeding from the egg, we can only say that the insect breeds all summer and that it apparently hibernates in the larval stage, as indicated by the late date of Prof. Comstock's larvæ, mentioned above.

INJURIES TO VEGETATION.

This species has been repeatedly bred by us from corn, during the present year, the larvæ being found in May and June folding the young leaves of the plant from side to side and feeding within the cylindrical case thus formed.

By Prof. Comstock it was reported injurious to clover, both white and red, near Washington, folding the leaflets into a kind of tube by drawing the edges together with silken threads spun for the purpose. "Sometimes," he says, "they spin two leaflets loosely together, or to the flower head when they are nearly full grown. They issue from either end of this tube, and feed upon the surrounding foliage, of which, when the larvæ are young, they eat only the under surface, leaving the veins and the epidermis of the upper side intact, but when nearly full grown they eat irregular holes through the surrounding leaflets and flower heads.

These larvæ are very active when disturbed, and wriggle from their tubes, suspending themselves by a single thread, by which they can let themselves down to to the ground, and if further disturbed, they wriggle about with great energy."

In addition to the plants above mentioned, this leaf-roller has been found by Packard upon the pine, and by others upon the locust, grape, strawberry, cotton, and orange. Mr. Coquillett bred it from *Verbena hastata*, Dr. Kellicott from *Ranunculus acris*, Mr. Walsh from grass and willow. We have bred it this summer from the following list of plants besides corn: common burdock (*Lappa major*), red clover, *Verbena urticifolia Monarda fistulosa*, and *Erigeron canadense*. Although its injuries have not been reported serious, its wide distribution, its abundant food resources, and the number of successive broods, bring it within the list of species capable of serious mischief under favoring circumstances.

NATURAL ENEMIES.

Prof. Comstock says, "One of the larvæ on clover was found to be infested with a hymenopterous parasite, which, however, failed to emerge."

In our own breeding cages three hymenopterous parasites emerged this summer, all true Ichneumonidæ.

3. The Red-Banded Leaf Roller.

(*Lophoderus triferanus*, Walk.)

Order Lepidoptera. Family Tortricidæ.

This species occurs somewhat rarely in Illinois, and has not been reported throughout its wide range to do any injury except to the cranberry in Massachusetts, where its larva is locally known as one of the cranberry worms. We bred it, however, during this past season, from pale green leaf rollers in young corn, and consequently may regard it as worthy of brief mention, especially as its local abundance in cranberry plantations in Massachusetts would indicate a capacity for excessive multiplication which makes it a possible source of danger in the great corn fields of the Mississippi Valley.

The presence of this larva and of that of the sulphur leaf roller just treated, is indicated in corn fields by the folding lengthwise or rolling of the leaves in May and June. If these leaves be opened, a green wriggling larva will be found enclosed in a web within.

The moth hatching from these folded leaves in June, if *Lophoderus triferanus*, may be recognized as an insignificant brown species, about a half inch across the spread wings. The fore wings are reddish brown except on the terminal fourth which is gray speckled with black, as is also the basal half of the posterior edge of the same wings.

A more detailed description is given beyond.

The species was first described by Walker in 1863, as *Cacœcia triferana*, and again by Clemens in 1865, in the proceedings of the Entomological Society of Philadelphia, under the name of *Tortrix incertana*. A better description of the moth, with figures of male

and female, is given by Robinson in Volume II, of the Transactions of the American Entomological Society, under the same specific name.

As an injurious insect it is mentioned by Dr. Packard in the Massachusetts Agricultural Report for 1870, and in the Tenth Report of the Geological and Geographical Survey of Colorado and Adjacent Territory, 1876. By Miss Murtfeldt it is reported as injurious to the rose, in the third volume of the American Entomologist (1880), and by Prof. Lintner as a clover insect in the Annual Report of the New York Agricultural Society for the same year.

In all the foregoing articles except the first, this species is treated under Clemens' specific name, but in Fernald's Catalogue of the Tortricidæ of North America, (1892), this is reduced to a synonym of Walker's *triferanus*. The larva was not distinguished in our breeding cages from that of the preceding species (*Dichelia sulphureana*), consequently I am unable to give a detailed description of it. Clemens' description of the imago is as follows:

Palpi ochreous or brownish ochreous except the minute third joint which is blackish. Head and thorax ochreous or brownish ochreous.

Anterior wings pure pale reddish brown within the central fascia, except on internal margin, which is broadly covered at base with blackish brown scales forming a rather prominent irregular spot followed by an aggregation of intermediate pale ochreous and blackish scales to the fascia. Central fascia broad, distinctly dark brown, sometimes reddish brown. The sub-apical costal spot is dark brown and separated from the central fascia by a reddish brown shade. The remaining outer portion of the wing pale ochreous except a testaceous brown spot above the anal angle. Fringes dark ochreous.

Posterior wings fuscous above, testaceous beneath. Fringes pale testaceous, much clouded centrally with dark fuscous.

Expanse, male 15, female 19 mm."

This species has been collected from Maine and New York to Illinois and Texas, and has been found feeding on the cranberry, elm, soft maple, oak, apple, rose, beans, *Gnaphalium polycephalum*, clover, strawberry, and corn.

Our specimens, collected on May 29, emerged June 30.

4. The Common Lady Bug.

(*Hippodamia maculata*, DeG.)

Order Coleoptera. Family Coccinellidæ.

There are a thousand things in the experience of every naturalist to show that the adjustments of Nature are rarely exact.

Even the best of our zoölogical friends occasionally turn against us. The most insectivorous of birds fails to discriminate in its captures between the enemies and the friends of man, and the re-

nowned "lady bugs," kindly looked upon by the whole civilized world as friends of no uncertain color, have also occasional lapses from virtue, when pressed by hunger or actuated by whim.

The common spotted lady bug is often abundant in corn fields, where, as dissection usually demonstrates, it is in search of the falling pollen of the plant, or of minute fungi which speck the withered leaves, or of the plant lice which infest the foliage, tassels, and husks; but last August, we saw it eating the exposed kernels at the tip of the ear, hollowing out their substance, and partly buried in the cavities thus made.

But it is perhaps fortunate that the lady bugs have the power of sustaining themselves for a time on other than their favorite food, for no one who knows the efficiency of this species as a check on the multiplication of the corn plant louse can fail to yield it gladly the few kernels of corn needed to tide it over a period of dangerous scarcity of its animal food.

5. The Brassy Flea Beetle.

(*Chætocnema pulicaria*, Cr.)

Order Coleoptera. Family Chrysomelidæ.

This abundant little flea beetle, one of the commonest and most widely distributed, was twice noticed in young corn during the last season in numbers sufficient to inflict noticeable injury at the time, by riddling the leaves with small holes.

6. Leaf Hoppers.

Tettigonidæ.

Jassus inimicus, Say.

Cicadula nigrifrons, n. s.*

Cicadula quadrilineatus, n. s.*

Macropsis nobilis.

Among the various species of leaf hoppers found upon young corn, those above mentioned have occasionally occurred in our experience in sufficient numbers to injure the plant appreciably in June and July. The three species first mentioned are more fully treated under the head of Insects Injurious to Wheat.

7. Grasshoppers (Acrididæ) in Corn.

The damage done to Indian corn by the common species of grasshoppers has been often enough reported, and is known to every one, but the species responsible for it have rarely been precisely

*See page 63.

identified. During the present season the following species have been found noticeably injurious to this crop in Illinois:

The Red-Legged Grasshoppers, *Pezotettix femur-rubrum*, DeG., and *P. atlanis*, Riley. The most evident injury to corn done by these species which came to my knowledge, was that reported by Dr. F. W. Goding. In a letter dated August 29, he says: "For the first time in my life I have this summer seen damage done to crops by locusts. The corn bordering on grass lands has been considerably injured, causing the ear to be small and undeveloped. They ate the leaves, husks, tops and ends of the ears. The injury was done by the *femur-rubrum* and *atlanis;* also many narrow winged 'katydids' were with them." [Probably *Orchelimum vulgare.*]

Acridium americanum, Drury.—In Union and Perry Counties, in September this great bird grasshopper (so closely related to the Egyptian locust as to startle one as he notices its abundance in extreme Southern Illinois), was occasionally found doing considerable damage in the borders of cornfields, sometimes completely stripping the stalks of leaves. It never swarms, however, and has not the dreaded power of migration of its relative, and has hitherto done no serious injury.

Caloptenus differentialis, Thos.—This species, one of our most abundant, was the commonest grasshopper in cornfields in Southern Illinois this fall, feeding not only on the leaves, but on the corn at the tip of the ears, and sometimes gnawing down the side of the cob.

Orchelimum vulgare, Harris.—In some situations this common grass locust was about as abundant as *Caloptenus differentialis*, and similarly injurious.

8. A Contribution to the Life History of the Corn Plant Louse.

(*Aphis maidis*, Fitch.)

Order Hemiptera. Family Aphididæ.

By H. Garman.

Our knowledge of this insect is made up of scattered contributions which have been made from time to time since the year 1856, when Dr. Asa Fitch, in his second report on the noxious, beneficial and other insects of the State of New York, named the insect and described the aërial form. At the time his report was written, Dr. Fitch had seen only the larva, wingless female, pupa and winged female of the aërial form, and these were supposed by him to occur only upon the peduncles of corn ears.

Mr. B. D. Walsh next discovered the root form and described its larva, apterous female, pupa and alate female (Proc. Ent. Soc. Phil., 1863, and Trans. Ill. State Ag. Soc., 1865). He mentions the fact that this form is attended by small ants.

In his list of the plant-lice of the United States, published in Bulletin 2 of the Illinois State Laboratory of Natural History, 1877, Dr. Cyrus Thomas adds to our information the statement that the aërial form occurs on the corn silks as well as on the ear-stalks.

In the years following this until 1882, the notes on the corn louse which appeared in periodicals added nothing new to its history, being chiefly repetitions of the matter given in the three articles above referred to. But in the Stark County (Illinois) News in 1882, Dr. E. R. Boardman published an account of the insect in which we find a few facts additional to those already given. The aërial form is said by this writer to appear on the tassels in the latter part of July and to be also attended by small ants. The lice are said to occur "all the way up the stalk," are badly parasitized by a small ichneumon fly and are preyed upon by the lady bug, *Coccinella 9-notata.*

Prof. S. A. Forbes in his report for the year 1882, as Illinois State Entomologist, adds the three lady bugs, *Hippodamia maculata, H. convergens,* and *H. glacialis* to the list of corn plant louse enemies, and the ant which attends the lice is identified by him as *Lasius flavus.*

The next addition appeared in the third biennial report of the Kansas State Board of Agriculture, 1883. In this report Mr. E. A. Popenoe states that he observed in his state, corn plant lice living upon sorghum cane and found the larvæ of a syrphus fly preying upon them.

The latest of the more important contributions appeared in Prof. Forbes' report as State Entomologist for 1883. In this article, broom corn is added to the list of corn louse food-plants and exact data as to the occurrence of the two forms during the season are given. Panicum, a common grass of corn fields, is shown to be a possible food-plant.

These authors have given us the essential facts as far as they are at present known. Besides their work only a few scattered notes and more or less imperfect summaries of the information they give, have appeared in print. As thus recorded the history is imperfect in several important particulars. (1) It does not tell us where the males and egg-laying females appear and when and where the eggs are laid, and (2) it does not tell us positively what relation the root and aërial forms bear to each other. It was with the purpose of deciding these points that the observations recorded in what follows were undertaken.

A marked irregularity in the growth of corn often noticed in the spring of the year, is frequently found on investigation to be the result of attacks of the root form of the corn louse, and large colonies will in such cases be found on the bases of the stems and on the roots of the dwarfed plants. Such plants frequently do not recover from the damage done them, but yield at the harvest, if anything, small or imperfect ears. The aërial lice also sometimes dwarf the plants where they occur in great numbers, but when the fore part of the season is favorable, the plants gain such a start by the time this form appears that subsequent injuries will not check the growth.

The damage wrought by these insects occasionally reduces a crop one-half or three-fourths, but damage so severe as this is exceptional and confined to limited areas. The uniform presence of the lice, however, and their wide distribution, taken with the value of the crop they affect, makes them very damaging pests to the people of this

State. Taking the acreage for corn in Illinois as 6,586,201, the the number given in the report of our State Agricultural Department for 1882, an average loss in a year of as little as one bushel to each ten acres would amount to about 658,620 bushels of corn, representing at least $100,000 in money, an amount sufficient to pay the expenses of a State Entomologist for fifty years.

NOMENCLATURE.

All those who have written upon the corn louse, with the exception of Prof. Forbes, have used without question the technical name *Aphis maidis*. There can be little doubt, however, that the corn plant louse belongs to the genus Rhopalosiphum, as this genus is used by the great authorities on the classification of aphides. The characteristic swollen cornicles are not as well marked as in some members of the genus Rhopalosiphum, but will serve at a glance to distinguish this species from members of the genus Aphis. The old name has so frequently appeared in these reports that a change is not deemed desirable here.

DESCRIPTION.

Winged viviparous female [root form].—Head black. Thorax brownish black. Abdomen above pale green with about three marginal black spots and numerous small, dark specks over the surface. Antennæ dark with pale at the articulations. Prothorax pale in the middle; meso- and metathorax chiefly brown. Cornicles black with some black at their bases, chiefly inside. Cauda dusky, with several transverse dusky marks before it. Thorax chiefly dark below, with interspaces about bases of limbs brownish. Under side of the abdomen pale green; two transverse dark marks before the cauda. Legs mostly black; tibiæ for basal two-thirds pale. Length of body 1.8 mm.; width of body, .9 mm.; antennæ, .7 mm; cornicles, .12 mm.; wing, 2 mm.

Pupa of winged viviparous female [root form].—Head obscurely dusky. Thorax obscure reddish brown. Abdomen above pale dull green, without spots. Antennæ dusky only at tip. Eyes reddish-brown. Wing-pads obscurely dusky. Cornicles black. Cauda dusky. General color below greenish. Rostrum dark at base and tip. Tarsi and tips of tibiæ dusky. Length of body, 1.61 mm.; width of body, .8 mm.

Wingless viviparous female [root form].—Head black above. Prothoracic segment black; the following three body segments each with a transverse dusky mark on their middles. Abdomen pale green, with black marginal spots and with numerous smaller specks over the surface. Antennæ dusky at tip and slightly also at base. Eyes reddish brown. Cornicles black. Cauda dusky; preceded by two transverse black marks. Abdomen beneath with two transverse black marks before the cauda, otherwise nearly uniform pale green below. Rostrum black at base and tip. Coxæ, femora chiefly, tips of tibiæ and the tarsi black. Body widely oval in outline. Antennæ short, about half the length of the body and head; first and second articles equal in length, first largest; third article

longest; fourth and fifth subsequal and about equal to the thickened proximal part of the sixth. Cornicles short, tapering towards the tip, not swollen, extremities flared. Cauda short and wide. Length of body, 1.4 mm.; width of body, .93 mm.: antennæ, .57 mm.

The young of this form are paler in color and have proportionally longer rostra and shorter cornicles.

Winged viviparous female [aërial form].—Head black. Thorax chiefly black above. Abdomen pale green, faintly bluish at sides, with three marginal black spots on each side preceding larger spots which surround the bases of the cornicles. Antennæ chiefly black. Cornicles black. Cauda green, edged with black. Segments behind the cauda dark-edged. Head and thorax beneath chiefly black. Abdomen pale green, with two transverse black marks preceding the cauda. Legs pale at their articulations; middle part of tibiæ often pale. Rostrum chiefly black. Body more slender than that of the female of the root form. Antennæ rather long; fourth and fifth articles each longer than the basal part of the sixth. Cornicles moderately long, swollen in the middle. Length of body, 2 mm.; width of body, .87 mm.; antennæ, about .85 mm.: cornicles, .2 mm.; wing, 2.65 mm.

Pupa of winged viviporous female [aërial form].—Head dark brown, often presenting an appearance of two longitudinal dark bands. Body chiefly pale green. Wing-pads, cornicles and tip of cauda black. Antennæ chiefly dark. Beak dark at base and tip. Legs nearly all dark; tibiæ pale proximally. Length of body. 1.6 mm.; width of body, .62 mm.; antennæ, .7 mm.; cornicles, .12 mm.

Wingless viviparous female [aërial form].—General color pale green, with cauda, cornicles and greater part of the rostrum, antennæ, and legs black. Head with two broad, approximated, longitudinal dark bands which give the prevailing color. Abdomen with the usual marginal black spots and the black patch about the base of the cornicles. Antennæ dark at base and apex. Eyes reddish brown. Anterior legs mostly pale. Rostrum dark at base and apex. More slender than the female of the root form and of a brighter green color. The cornicles are swollen in the middle. Length of body, 1.97 mm.; width of body, 1 mm.; antennæ, .75 mm.; cornicles, .17 mm.

The young of this form differs from the adults in the same manner as do those of the root form, *i. e.* they are more slender, have longer beaks and shorter cornicles.

Towards fall the green color worn by the adults is changed for darker colors and often females which are still giving birth to young are bluish black. A meal-like coating can be detected on the bodies by examination with a lens.

LIFE HISTORY AND HABITS.

Naturalists hold to the belief that it is not in accordance with natural law that a species of animal should reproduce indefinitely without the union of the male and female sexes. It is true that when supplied with heat and food artificially, certain species of Aphides have been induced to reproduce for long periods without

marriage, but it is held that this could not be continued for any great length of time without injury to the species, and eventually, it is thought, would result in its extermination. There are certain species of plant lice, however, of which no males or oviparous females have been seen. Such species are thought to produce males and egg laying females locally or only at seasons which from some unknown cause are especially favorable to this method of reproduction.

Observations made by the writer during the past season indicate this habit for *Aphis maidis*. From the latter part of May when this plant louse appeared on the corn till the middle of November when the corn had long been dry and the ground had been many times frozen, the corn louse was followed with special care; and though hundreds of individuals were dissected under the microscope, only wingless and winged viviparous females were seen during the season. About October 6th, most of the sorghum cane in Central Illinois was ripe and ready for the mill. *Aphis maidis* had been during the season abundant on the blades and to save itself must now depart. Upon examination the species was found to be represented mostly by pupæ and alate females. The pupæ, as was found by confining them, were rapidly maturing and the winged adults were leaving the sorghum and scattering in all directions. While standing at the edges of such fields at this time one's person interrupted the flight of many of these winged lice. The roots were now carefully searched for the root form, but it was not to be found in places where at the beginning of the season it was common. Whole plants were searched with the glass for eggs, and, though some of them had afforded nourishment to hundred of aphides during the summer, no eggs could be found. The lice which were thus forced to leave the sorghum field doubtless resorted to the corn, which was less advanced and for some time afterward continued to furnish them appropriate food.

With the advance of the season the lice upon corn were also deprived of food. But in this case the irregular development of the stalks which prevailed in most fields served to collect the lice into great colonies by driving them gradually from their stalks to the greener and less matured ones. At the last most of the lice were to be found between the outer husks of the greener ears and upon dwarfed and immature stalks. These had not all collected there as winged females, for the wingless louse showed itself capable of leaving a stalk and finding a better one. Both wingless and winged females of of the aërial form were now isolated and confined: both were found to give birth to living young. On the ninth of November numerous specimens were collected in the fields and carried to the house. Among them were many winged females, some pupæ and a few young. All proved to be viviparous. Some of them were alive November fifteenth; on the twentieth of this month the last winged female died with its body distended with matured embryos (11 were counted.) The last to succumb was a pupa which died some days later.

The specimens seen in the fields November 9th, were the last ones observed alive out of doors. Previous to this date there had been severe frosts, and the corn was nearly all dry and hard. The

lice obtained at this time were found chiefly among the husks of nubbins and in crannies between the ensheathing part of the leaves. They were evidently restless, and the warmth of the sun at midday aroused some of them to endeavors to find better quarters. These were found wandering about the stalks. An almost microscopic examination of stalks which had supported thousands of aphides was made after the lice disappeared without finding an egg. The root form of the corn louse has not to my certain knowledge been observed later than October 8. Its period has probably passed and its purpose been served when the warm weather of July comes on, and with it the aërial form. But to make sure as to whether or not this form was hibernating in the ground, the roots of weeds, grasses and corn in cornfields were searched in November, but without finding them. In the same fields at this time, the hibernating viviparous females of *Schizoneura panicola* were abundant on the roots of blue grass and timothy.

From these observations, it seems to me evidently either that (*a*) *Aphis maidis* matures its egg-laying brood locally; (*b*) that this brood matures on some plant other than corn, or (*c*) that the brood appears at intervals greater than one year, the species being in the meantime maintained by hibernating viviparous individuals.

(*a*) The area over which the foregoing observations were made will doubtless be quite uniformly infested early the coming spring with corn plant lice. That these lice can have been so distributed over so extensive an area, and at so early a date after hatching from the eggs of locally developed oviparous females, can not be believed.

(*b*) If eggs were produced on some plant other than corn, it must have been by plant lice born of the viviparous females which deserted the corn. The development of such a brood would have been possible even after the first of November; for *Aphis mali* matured its oviparous brood on the apple trees after this date. When the winged viviparous females of the corn louse began to mature rapidly and scatter through the fields in the fall, close watch was kept of available plants to see whether or not the lice resorted to them for this purpose. Volunteer corn, which grew up along railroads late in the season, became almost invariably stocked by these migrating individuals, but on no other plant could the adults and young be found. Wheat, oats and the perennial grasses seemed to be the most likely to be resorted to, and the roots and stalks were thoroughly examined. The lice peculiar to these plants were often found in very great numbers, but in not a single instance was anything found established on them which could be taken for *Aphis maidis*.

(*c*) The hypothesis that the lice hibernated as alate viviparous females was the only one, then, left to me, and though not thoroughly satisfied with the nature of the evidence, I am disposed to believe that this is the usual manner of passing the cold months, and that the oviparous brood appears only under specially favorable circumstances, perhaps locally. This conclusion is held subject to revision. It is what seems *most probable* with the results of two seasons observation before me.

The following observation bears upon the relation of the root and aërial forms to each other. On the 25th of June a number of the root form were colonized on the roots of corn growing in the laboratory, and on the 5th of July one of these lice was observed to have established itself upon one of the leaves. On the 6th of July it was found to have given birth to two young during the preceding night. Others of the root lice were observed upon the leaves, but the plant at this stage began to die, and the experiment ended. I have little doubt, however, that this would have proved the beginning of a colony of aërial corn lice.

In the light of these observations, the history of the lice during the year seems to be this: Reproduction is carried on during the warm months by the viviparous (mostly wingless) females of the aërial form. In the fall viviparous winged females predominate, serving to distribute the species and (generally) by hibernating pass it over the winter months. In the spring these females resort to the roots and bases of the stems, where they are then protected from the cold, and multiply here until the warm weather of the latter half of July sets in, when their descendants migrate to the leaves, husks and silks, founding there the colonies of aërial lice.

An account of the life history of this plant louse would be imperfect without some notice of the little ant, *Lasius flavus*. In the spring this ant is almost invariably to be found with the root lice, carefully guarding the latter, and when the burrows are exposed carrying them away and concealing them in the earth. During the fore part of summer it occurs on the plants among the aërial lice, but when the dry season of late August and early September sets in, it burrows deep into the earth and is not often seen except after rains, when it opens up its burrows. With the fall rains it again comes to the surface and may be found to the end of the season with its young and colonies of *Schizoneura panicola* on the roots of grasses. Its purpose in attending the corn louse is doubtless to secure the sweet fluid which a tap from an antenna will cause a full fed louse to eject.* But I am disposed to believe that the ants attend *Schizoneura panicola* for the purpose of browsing upon the waxen coat which covers that species. I have several times seen the ants gathered about a detached mass of this wax and apparently eating it. In some nests of these ants one finds in winter masses of plant lice eggs which have been collected the previous fall. The ants carry these about as the do the plant lice. Why they are collected, I am unable to say. A natural inference is that they collect them to stock plants in the vicinity of their nests in the spring.† It may be they are used as food, as, indeed, from the results of some experiments in keeping them indoors I suspect the lice are occasionally.

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* During the past summer I have repeatedly seen the ants secure this favor, and to my surprise the sweet droplet was always discharged from the vent, never from the cornicles.

† A quantity of these eggs were collected last spring and given to a colony of ants kept in doors. They hatched small green plant lice which at once scattered in all directions. They would not make their home on any of the plants offered them, and so were lost.

The following table shows the dates at which the lice have been observed. It is deficient in not showing the relative abundance at the different dates of the stages, larva, pupa, and adult females:

Date.	Root Form.				Aerial Form.			
	Larva.	Pupa.	Winged female.	Wingless female.	Larva.	Pupa.	Winged female.	Wingless female.
May 16	×	×		×				
" 22				××				
June 1				××				
" 6	×	×	×	××				
" 7			×××					
" 13								
" 25	×		×					
" 29				××				
July 3				××				
" 6	×							
" 21	×							
" 25	×			×	×	×	×	×
" 28					×			
" 29			×	×				
" 31					×	×		
Aug. 2					×	×	×	×
" 11					×	×	×	×
" 20					×	×		×
" 28					×	×	×	
Sept. 4					×		×	×
" 5					×	×	×	×
" 6				×				
" 8								×
" 18							×	×
" 19					×			
" 22								×
" 25						×		×
Oct. 2					×	×	×	
" 6					×	×	×	×
" 7					×	×	×	×
" 8	×			×				
" 9					×		×	×
" 17					×		×	
" 25					×	×	×	×
" 30					×	×	×	×
Nov. 1					×		×	×
" 8					×		×	×
" 9					×	×	×	
" 15						×	×	

The species will probably be found to occur in every county of the State. We have observed it or had it reported from the following: Stephenson, Ogle, DeKalb, Rock Island, Kendall, LaSalle, Putnam, Stark, Livingston, Warren, Peoria, McLean, Tazewell, Mason, Menard, Champaign, Morgan, Jersey, Fayette, Effingham, Marion, White, Madison, Union, and Pulaski.

PARASITES AND PREDACEOUS INSECTS AFFECTING THE CORN LOUSE.

A most efficient check on the further increase of the corn louse exists in a small four-winged fly, belonging to the genus Adialytus, which deposits its eggs within the bodies of the lice and in its larva state feeds upon their tissues. The greater part of a colony of the lice is sometimes thus infested, the lice containing the grubs which hatch from the eggs being known by their brown swollen bodies, or at an earlier stage by a slightly yellowish color. The adult Adialytus is a slender, active ichneumon fly, about .06 inch in length. Its feelers and legs are long and slender and the abdomen is very flexible so that it can easily be bent upon itself. The

general color is black, with yellow mouth-parts and legs. The wings are transparent and beautifully iridescent under the magnifying glass. The male closely resembles the female, but has two more articles in each of its antennæ and has the tip of its abdomen blunt instead of sharp pointed. The following more detailed description will serve to distinguish the species from those which infest other plant lice.

Adialytus maidaphidis, nov. sp. Head and thorax black, shining, smooth. Abdomen reddish brown, darkest on the middle of the segments, with a few short whitish hairs. Front with whitish hairs. Antennæ dull black. Mouth-parts pale honey yellow. Coxæ of anterior and middle legs, trochanters of all the legs, anterior and middle femora, anterior tibiæ and tips of middle and hind tibiæ honey-yellow. Posterior femora mostly black. Limbs clothed with appressed silky white pubescence, thickest on the tibiæ and tarsi. Hind coxæ black. Tarsi dusky. Wings transparent, iridescent, with some yellow at base and a basal half of costa. Stigma smoky brown, with a touch of yellow at its inner angle. Nerves black. Head subspherical. Eyes large and prominent. Three ocelli conspicuous. Antennæ of 13 articles in the female; with 15 in the male. Two proximal articles equal in length, shorter than the others, about as long as wide. The succeeding articles about equal in length, about twice as long as wide. Distal article in female longer than the others; in the male it is about equal to them. The articles are longitudinally, finely carinate. Thorax obovate, elevated anteriorly, impunctured. Abdomen spindle shaped, depressed, pointed in the female, blunt in the male. Legs long and slender; femora spindle-shaped, about three-fourths the length of the tibiæ. Tibiæ slender at base, gradually enlarging to their extremities. First article of tarsi long and uniform in diameter; about as long as the three succeeding together. Second article a little larger than the following ones and slightly swollen. Three distal articles subequal. Length, 2 mm.

During the summer and autumn these little flies may be seen running rapidly about on the corn which is infested with lice, and if watched will be seen now and then to approach a plant louse, tap it gently with the antennæ, and if the louse seems to be satisfactory, the abdomen of the parasite is suddenly bent downwards and then forwards between the legs, the victim is stabbed by the short, sharp pointed ovipositor and an egg is inserted at the same time in its body. The parasitized louse continues to feed after the egg has been deposited as if nothing had occurred to discommode it, and if young may continue to grow until the natural size is reached. All this time the great grub hatched from the egg is feeding upon its tissues and growing rapidly so that by the time it gets its growth the body of its host is swollen out greatly beyond the usual proportions. The grub seems to avoid the vital organs of its host until the last so that the louse does not entirely succumb until the grub is ready to become a pupa, at which time it seems to devour all the remaining tissues or crowd them aside to make room for itself. The body of the louse has by this time become brown and dry, and though outwardly looking like a very plump plant louse is really only a skin enclosing a parasite. By some means, not ascertained, the swollen body becomes *glued* to the leaves

and there remains until the parasite emerges. The grub of the Adialytus is yellowish white, thick-bodied and short. It lies bent upon itself and when removed is perfectly helpless. The pupæ lies in the same position, is also white, with the large eyes showing conspicuously at the sides of the head. The adult emerges within the dried skin of the louse it has inhabited and at once gnaws a round piece out of the back of the latter, generally near the posterior end of the body, and pushing this piece out emerges through the opening made. Often these pieces which are gnawed out adhere at one side, so that after the parasite has emerged they fall back in place and the empty skin looks much as before. The parasites emerge in great numbers in the fall of the year at the time the winged females become most abundant, and I believe many of them hibernate as adults. An examination of a great number of swollen plant lice in midwinter, however, reveals a few with living grubs. Lice that are infested with this parasite seem never to produce young, their whole existence being given up to bringing the unwelcome guests to maturity. The wingless females seem to suffer most from its attacks, by far the greater number of swollen bodies representing this form, but a good many pupæ and winged females also become infested. The greater immunity of the winged louse is probably due to its greater activity; when disturbed, in warm weather, it takes wing readily.

Syrphus Fly Larvæ.—Next to the small hymenopterous insect just described, the larvæ of small dipterous insects known everywhere as syrphus flies are most destructive of the lice. These larvæ are considerably larger than their prey, and spend their time creeping about among the herds of lice on the corn ears and tassels. They seize the plant lice in their mouths, and in a few minutes have sucked out all their juices. Great numbers of lice are destroyed by a single larva in the course of a day, as they are very active and voracious. They occur throughout the summer months, and are sometimes found as late as November. Their empty pupa skins are sometimes found with a round hole in the posterior part, from which some parasite, has emerged.

The Syrphus fly larva is elongate cylindrical, transversely wrinkled with a blunt posterior end, tapering more nearly to a point anteriorly. The head is not much different from the other body segments. On each side of the mouth is a black, hard, toothed jaw, which serves to hold the lice. There are no eyes. The color is pale green when the alimentary canal is filled with the juices of plant lice; at other times it is yellowish brown. Its length is about three-tenths of an inch.

The adult is a handsome two-winged fly, with large reddish brown eyes, transparent iridescent wings, shining, greenish black thorax, and with the abdomen alternately striped transversely with black and yellow. The head is chiefly yellow, with a frontal tuft of short, dark pubescence, and a wide black band extending down the front to near the base of the antennæ, with silvery pubescence behind the eyes. The three basal articles of the antennæ are orange yellow; the bristle is black. A wide yellow stripe extends from the anterior margin of the thorax on each side to the bases of the wings, where

they terminate abruptly. Legs pale yellow. Interior surface of abdomen also pale yellow.

Larvæ of this fly kept in confinement, pupated during the first part of August, and the flies emerged between the fifteenth and twenty-fifth of September. During this period the larvæ were observed among the lice in the fields, a fact which indicates several broods during the summer. The only flies obtained were accidentally destroyed, and their species can not therefore be definitely determined. The larvæ creep like leeches, and when they have seized a plant louse, raise the anterior part of their bodies so as to prevent the struggles of the prey freeing it from their grasp. A European species is said to devour as many as one hundred plant lice in an hour. I have watched our species on several occasions, and even when hungry they did not finish one louse in less than five minutes, and three or four lice at one time seemed to satisfy them. Generally but one or two larvæ occur in a colony of lice.

The Smaller Two-Spotted Lady Bug (*Hyperaspis signata*, Oliv.)—This lady bug has a reputation as a destroyer of the destructive bark louse of the maple trees. It occasionally occurs also among the herds of corn plant lice in the corn fields.

The Plain Lady Bug (*Cycloneda sanguinea*, Linn.)—The adult of this lady bug is also found among colonies of lice. It is less common as a rule than the following species, but in some fields in the south part of the State which we visited, it was the more abundant of the two.

The Spotted Lady Bug (*Megilla maculata*, DeG.)—This lady bug is common in all its stages upon corn and destroys great numbers of lice. In the autumn and winter great numbers of the adults, sometimes thousands in a heap, may be found under boards at the edges of the corn fields.

Two other lady bugs, *Hippodamia glacialis* and *Coccinella 9-notata* have been observed in the fields but neither occur in sufficient numbers to be of any great service.

The Lace-winged Fly (*Chrysopa* sp.)—The larvæ of one or more species of these flies are frequently seen devouring the aphides, and occasionally are locally abundant in the fields.

Artificial Remedies.

Of artificial remedies but little can be said. The corn fields are so large that an application of any of the insecticides which can be used successfully for smaller crops would be impracticable. The parasites and predaceous insects may be depended upon to prevent any general increase in the numbers, and where local outbreaks occur, more than one season's serious damage can probably be avoided by burning off old fields in the fall as soon as the corn is husked, and to some extent also by planting on ground which has not been in corn. For garden corn the use of a solution of kerosene emulsion thrown upon the corn from a garden engine carried on a cart would be sufficient to destroy the lice.

ARTICLE II.—NOTES ON INSECTS INJURIOUS TO WHEAT.

1. The Larger Wheat Straw Worm.

(*Isosoma grande*, Riley.)

Order Hymenoptera. Family Chalcididæ.

In May of this year, Mr. Garman collected from wheat fields in Clark county, in Eastern Illinois, and sent to the Laboratory (where they were received May 21,) straws containing a larva similar to that of *Isosoma tritici*, but larger, and evidently differing from that in life history. These were imbedded in the center of the stalk, just above the lowest joint, where they caused a bulbous enlargement of the stem, the plants containing the insects being dwarfed or killed in every case noticed. The fact that the inner surface of the stem containing the larvæ had been eaten and torn was plainly perceptible.

On the 6th of June, the living, winged adults emerged from these examples, and all the remaining straws contained at this time pupæ in the pupal envelope. The straws had been kept too dry, however, and the insects had died within them. On the 24th of May, adults of this species were found not uncommon in wheat fields at West Union, and on the 27th at Mount Carmel, in Wabash county, where a few stalks of wheat which had been evidently inhabited by the worm were likewise noticed. At Carmi, in the same county, on the 30th, stalks which had been injured by them were again observed, although none contained the larvæ; but several imagos were taken within them, as also at Eldorado on the day following. At Villa Ridge, on the 3d of June, many dwarfed stalks of wheat were found in the fields from which this species had apparently emerged, but no specimens were taken here by sweeping. No further observations were made upon this species throughout the year, but I learned from Mr. F. M. Webster, an assistant to the Entomologist of the United States Department of Agriculture, that he found it afterwards in wheat fields in Indiana, near the Illinois line.

[From the last Report of the United States Entomologist (1884),*

*Page 385.

received since the above was written, I learn that Mr. Webster found this larva at Normal on the 29th of May.

Some of the specimens obtained by Mr. Webster, were described by Mr. Riley under the name of *Isosoma grandis* in the Bulletin of the Brooklyn Entomological Society for December 1884, pages 111 and 112, with the remark that they were reared from wheat stems in June.

DESCRIPTION.

The following description is in part compiled from that of Mr. Riley and in part drawn from specimens bred and collected by us.

Length of body from 4.2 to 4.3 mm.; expanse 7.6 mm.; antennæ slender, little clavate, but about half the length of the thorax, the latter smooth except the mesonotum, which is decidedly rugulose. Wings large, yellowish in color, less hyaline than those of *Isosoma tritici*, the veins reaching the outer third, the sub-marginal four times as long as the marginal. All the specimens observed were winged females. Abdomen equal to or longer than the thorax, somewhat stouter than in *Isosoma tritici*, ovate-acuminate in form. The head is tawny, with a narrow black shade down the middle, and another beneath the eye, the posterior surface black. The scape of the antennæ and first joint of flagellum yellow, the remainder black. The pronotum is large, and a brighter yellow than that of *tritici*. There are two tawny spots upon the back, and the propectus is yellow in front. There is also a large tawny spot upon the pleura, above the middle coxæ. The abdomen is shining black throughout, (except the tips of the anal appendages, which are yellow), and is very sparsely covered with pale hair averaging about one-half the length of the segments to which they are attached. The tarsi are yellow, as are also the anterior tibiæ in front and within, the other tibiæ being tawny and more or less shaded with dusky. The anterior coxæ are yellow in front, the posterior yellow externally. The femora have each a definitely limited suboval yellowish spot below, near the tip, extending two-fifths the length of the femur on the front pair, smaller on middle pair, and shorter and less definite on the posterior.

From *Isosoma tritici*, to which this species is most nearly allied, it may be distinguished by its larger size and especially by the far greater amount of tawny and yellow colors. The larva is about 6 mm. in length, of a greenish yellow color, distinguished from that of *tritici* only by its larger size.

The pupa, from 4.5 to 5 mm. long, varies in color from white in its earlier stages, to the colors of the adult when prepared to emerge. It is distinguished from that of *tritici* by its larger size and in all our specimens by the presence of wing pads folded around the posterior legs.

LIFE HISTORY AND DISTRIBUTION.

Although this species has been observed over so short a period, the facts specified are such as strongly to indicate that it is single-

brooded; that the eggs are laid by the adult upon the young wheat in autumn; that the larvæ hatch and hibernate within the stem, pupating in May and emerging late in that month and early in June. They leave the stem, in fact, at about the time the young *Isosoma tritici* commences its attack upon the wheat, and consequently these two species, although specifically clearly distinguished, nevertheless alternate like two broods of the same form.

Concerning the distribution of this species, it can, at present, only be said that it occurs in Western and Southern Illinois and in parts of Indiana adjacent. As this insect inhabits the wheat only during the period of the growth of the plant, escaping before the grain is harvested, and passing the interval as a free imago, it is difficult to see how its injuries may be prevented, unless, indeed, late sowing, as practiced for the Hessian fly, may be found to affect this straw-worm also.

2. The Lesser Wheat-Straw Worm.

(*Isosoma tritici*, Riley.)

Order Hymenoptera. Family Chalcididæ.

(Plate I, Fig. 5.)

Observations made during the present season add one or two points of interest to the life history of this destructive species. The period when it begins its injuries has heretofore been a matter of inference, but it was this summer found by Mr. Garman at work in the wheat as early as June 5, many of the larvæ being at this time only a millimetre in length, and evidently but recently hatched. The exact character of the injury produced by these young larvæ is well illustrated by the accompanying figure, exhibiting the cavity from which a very small straw worm was removed.

The parasitism of *Eupelmus allyni* upon this species and *Isosoma hordei* has been placed beyond question by recent observations of Prof. French, reported in the Canadian Entomologist for July, 1884, pages 123 and 124. As evidence on this point, he says:

"A single joint of rye containing several galls formed by *Isosoma hordei* was put into a bottle and corked up, so that no insects could get out or in. In due course of time a specimen of *E. allynii* was found in the bottle, and the hole from which it had gnawed its way out of one of the galls was plainly to be seen. Afterward the other galls gave forth *I. hordei*. In this case there could be no question but that the specimen of *E. allynii* came from the gall made by *I. hordei*. If no *hordei* had hatched from the other galls, this would have been evident, for the galls made by this species are too characteristic to be mistaken by any one at all familiar with their work.

I have bred quite a number of this species from the inside of the stems of wheat; and in all cases they came from the cavities inside the stalk that had been gnawed by *Isosoma tritici*. Though this species of Isosoma makes no gall, its manner of eating the

tissue around the inside cavity is rather characteristic, so much as to be readily recognized after a little observation. I have found a species of grass worked in by another species of an allied insect, but the manner of work is so different as to be unmistakable. *Isosoma elymi* makes a cavity on the inside of *Elymus canadensis* that is more nearly like that made by *I. tritici* in the wheat, but they differ somewhat.

In the fields I have found specimens of *E. allynii* emerged from the pupa skin, but still inside the cavity of the stem; others with the hole by which they expected to emerge gnawed so that they could almost get out, and they still there with the body protruding, and others when they had gone, the clean-cut hole indicating where they had obtained their freedom. I have bred many specimens from the straws after they had been collected, and the conditions were the same as those in the field, the inside of the stems in all cases being examined before putting them into the breeding jar.

From these facts I do not see how I could avoid the conclusion that *Eupelmus allynii* was a parasite on the two species of Isosoma."

As no description of this important parasite has yet appeared in the reports of this office, the original specific description of Prof. French, published in the Canadian Entomologist for January, 1883, is here appended, accompanied by an original figure.

Eupelmus allyni, French.

Order HYMENOPTERA. Family CHALCIDIDÆ.

(Plate I. Fig. 6.)

DESCRIPTION.

Female.—Average length, .10 of an inch. Color of body and antennæ uniform black, the first with a slight greenish luster. Head about .025 of an inch wide, about two thirds as long; the antennæ a little enlarged at the ends, hairy; microscopic hairs moderately scattered over the head and thorax. Thorax, as well as head, punctured; wings hyaline, dotted over with microscopic hairs, the thorax in its widest part about the width of the head. Abdomen gradually tapering from near the base, the ovipositor slightly exserted.

The color of the legs vary slightly; in five specimens the anterior and posterior legs have the femur fuscous except at the ends; the tibiæ with basal half fuscous, the rest yellow; the middle pair of legs are yellow throughout, except the terminal tarsi. Two specimens have all the femurs fuscous, yellow at the ends. One specimen has all the femurs pale red, and the tibiæ fuscous, but this is probably a change from yellow by the poison bottle used in killing. One is marked like the first five, with the yellow replaced by pale red; another is like the first five, except that the middle tibiæ are a little clouded at base.

Male.—In this sex the body, wings and antennæ are colored like the females, but the antennæ are a little more slender at their ends. The head and thorax have about the same measurements, but the

abdomen is a little shorter, the whole insect being from .06 to .07 of an inch. The legs have all the femurs yellow, front tibiæ yellow, middle and hind tibiæ fuscous, except at the apices, which are yellow; feet as in the females.

3. Contributions to a Knowledge of the Life History and the Parasites of the Hessian Fly.

(*Cecidomyia destructor*, Say.)

Order Diptera. Family Cecidomyidæ.

(Plates II and III.)

Notwithstanding the enormous losses inflicted upon agriculture in Illinois by this most destructive enemy of one of our important staple crops, the details of its life history, upon which strictly depend the value of measures for the prevention or control of the injuries, have not been fully or accurately made out for any part of the Mississippi Valley, the statements current on this subject appearing in agricultural papers and in the writings of our local entomologists, being mostly derived from the statements of Herrick, Fitch, Harris, and other observers, who have studied the species in the North Eastern States.

It is, beyond question, chiefly to its parasitic enemies that we owe such immunity from the Hessian fly as we now enjoy, these clearly constituting the principal natural check upon its continued existence in destructive abundance; but our ignorance of its parasites is even greater than that of its life history, for almost nothing definite has been learned concerning them since the observations of Herrick, of Connecticut, made in 1832; Certainly, therefore, time and labor spent in acquiring more definite knowledge of the details of the life history of the Hessian fly, and the number, kinds, seasons and habits of the parasites will be well employed, even if it should serve only to shake the confidence of our agricultural community in such remedial measures as may have been heretofore recommended.

As soon after entering upon the duties of State Entomologist as time and opportunity offered, I began observations upon this insect with the view and hope of constructing a complete account of its life history in the southern half of Illinois,—the only region lately affected by it, since winter wheat culture, although now rising to importance in the northern part of the State, has been too lately revived there to expose the fields to danger from the Hessian fly. The results here presented fall something short of a complete account of the life history of this insect throughout the year, but they nevertheless throw unexpected light upon the matter, and are deemed worthy of report as a statement of the present condition of the investigation.

Our observations were directed almost wholly to the midsummer history of the insect, the facts respecting its autumnal injuries and its hibernation being sufficiently well settled. As a fair example of the current view of the summer history, we may take the following account from Packard's "Guide to the Study of Insects":

"The flies appear just as the wheat is coming up; they lay their eggs for a period of three weeks, and then entirely disappear. The maggots hatched from these eggs take the flaxseed form in June and July, and are thus found in the harvest time, most of them remaining on the stubble. Most of the flies appear in the autumn, but others remain in the puparium until the following spring. By burning the stubble in the fall, their attacks may best be prevented."

It will be seen, however, from the observations here reported, that the above history is inaccurate for Southern Illinois, and that the remedy mentioned by the author is, as a consequence, to a great extent inapplicable.*

In following the life history of the fly through the season by means of breeding experiments and field observations and collections, the principal embarrassment has arisen from the immense prevalence of parasitism in the summer brood, so that breeding cages containing hordes of the larvæ and flaxseeds would yield scarcely a single fly, and fields in which they had destroyed the crop would send forth so few of the adult insects that the most diligent sweeping at the season of their emergence would not obtain a single specimen.

LIFE HISTORY.

1883.

Our observations for 1883 began at Centralia, April 10, at the time when the Hessian fly was abundant in the pupa state, and was also rapidly emerging in the winged form. From a large number of wheat plants containing the flaxseeds sent to Normal at this time, flies continued to emerge until the 20th of the month, after which no more appeared. These imagos laid their eggs in the breeding cages almost from the first.

On the 5th of May young larvæ of the spring brood were collected at DuQuoin, some of them scarcely more than hatched, and others full grown. These were placed in a closed fruit jar in a room adjoining the office at Normal, and kept under cover at the ordinary temperature of the out-door air; and to my surprise, on the 28th of May, *two imagos appeared* in the jar. Upon June 4, four more emerged, three males and one female, and others at intervals until June 15.

On the 17th of May, examples of both free larvæ and flaxseeds were received from Odin, in Marion county. On the 24th, we collected larvæ only, from wheat fields in Decatur, in Macon county,

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* It is but fair to state that in his later papers Dr. Packard revokes the recommendation quoted above, for the burning of stubble in fall, and describes it on the contrary as a measure likely to be productive of the greatest harm; but not on the ground that the flaxseeds, which it is intended to destroy, have most of them given exit to the fly, but rather on ground which seems to me wholly untenable, viz: that the harm done by the destruction of the parasites must far overbalance the benefit done by burning the flaxseeds in the field.

and on the 3d of June, flaxseeds were sent me from Macoupin county. June 12th, flaxseeds occurred in rye near Granville, Putnam county, and on the 26th they were found upon the bases of fallen stalks of wheat in fields near Warsaw, in Hancock county. On the 29th and 30th flaxseeds still unhatched, containing living larvæ, occurred in fields at Godfrey, in Madison county, and near Jerseyville; and on the 4th of July they were found in the ripened fields of wheat and in stubble at DuQuoin, in Perry county.

Careful sweeping of the infested fields at Warsaw, Jerseyville and DuQuoin, yielded no adults. At Effingham, on the 7th, great numbers of the flaxseeds, some of which were demonstrated to contain living larvæ, were found on the stubble, and also upon the standing grain where harvesting was in progress. In badly infested fields they collected upon the platforms of the harvesters in surprising numbers. At Anna, in Union county, on the 9th, the flaxseeds were also noticed in the stubble, and at Villa Ridge, still further southward, specimens were obtained at the same date, which afterward yielded the adult insect in our breeding cages. On the 20th July I made an examination of flaxseeds collected at DuQuoin on the 4th of that month, and found the larvæ in them still living, and not yet pupated. Some of these living larvæ were dissected, and it is certain that they had not been parasitized. On the second of August, at Anna, careful and long continued sweeping of the fields failed to procure any of the imagos. On the 5th August flaxseeds were again obtained from fields in DuQuoin, and on the 7th of that month others were sent me from the same locality which contained living larvæ, although many of them were empty shells, from which parasites had already escaped.

On the 6th September I received from an assistant in the field about fifty flaxseeds collected at Centralia, which I carefully examined. All but six of these were empty shells, and only one contained a demonstrably living and active larva. Three at least of the other five were dead, while the other two were soft and possibly living, but if so, dormant.

In sweepings sent from wheat stubble near DuQuoin, which had been previously infested by the fly, the adult insect was at this time found very sparingly indeed. Our next observations in this year were made Dec. 9, at Anna, where larvæ and flaxseeds were abundant, and on the 27th of that month their occurrence at Albion, in White county, was noted by a correspondent of the office.

1884.

Commencing April 9 of the present year the occurrence of flaxseeds was reported from Marshall county by a correspondent of the office, and on the 19th of May young larvæ, some of which were but a few hours hatched, were found by Mr. John Marten, a former assistant of my predecessor, Dr. Thomas. On the 21st of this month, larvæ were collected at Marshall by an assistant, which, kept in breeding cages at the ordinary temperature of the air, *yielded adult flies* on the 20th of June. On the 25th of May both larvæ and flaxseeds were obtained at Robinson, Crawford county, and on the 27th at Mount Carmel. Flaxseeds were found at Carmi and Eldorado

a few days later, and both free larvæ and flaxseeds were received from a correspondent at Robinson on the 2d of June.

On the following day flaxseeds were received from West Union in Clark county, which, placed in open fruit jars and moistened regularly, being otherwise exposed to conditions as exactly similar to those prevailing in the fields as I was able to supply in the Laboratory, *yielded adults* from the *22d* to the *28th June*, while flaxseeds obtained at the same date from Villa Ridge, in extreme Southern Illinois, *gave the imago* from the *17th* to the *20th* of that month. Flaxseeds obtained on the 4th at Anna, in Union county, yielded the adult on the 22d. Flaxseeds occurred again on the 6th and 7th at DuQuoin, and stalks received from Robinson on the 14th contained a number of them and a single partly grown, naked larva. Flaxseeds were collected at Robinson on the 17th, at Anna on the following day, at Robinson on the 20th, and at Anna on the 24th.

Specimens of flaxseeds received from Robinson on this date *yielded the adult fly* in our breeding cages four days later. In Marshall on the 25th, and at Robinson on the 27th and 30th, flaxseeds were collected. One of those from the place last mentioned was found, when opened, to contain a living larva; but others were evidently dried up, and several had already yielded parasites when collected. Those obtained from Marshall on the 25th were found in the same condition, several containing living larvæ and others being dried up or parasitized.

On the 28th *imagos were noted pairing in the breeding cages*, having just emerged from the flaxseeds obtained June 3 at West Union. At Anna, on the 1st July, a most thorough and long continued search in previously infested fields was made for the adult fly, the stubble and still standing grain being carefully swept by us and the shocks of grain being examined at great length. Situations adjacent to the wheat fields likely to yield the fly were also carefully gone over; but while numbers of other species of Cecidomyidæ were collected, not a single adult Hessian fly resulted from this search.

Flax seeds still continued to come in from Eastern Illinois,—some empty shells and others containing healthy larvæ being received on the 1st and 5th July from Marshall, on the 7th from Villa Ridge, and on the 12th from Anna.

On the 5th of this month a most extended and careful search was made again in wheat fields near Anna by Mr. C. W. Butler, with the same negative results as those of July 1, and my faithful correspondents, E. C. Madison, of Marshall, and Thomas S. Moore, of Robinson, both reported that they were unable to find the imago. Unopened flaxseeds still occurred at Anna on the 12th, and on the 14th of that month my assistant, Mr. W. H. Garman, carefully, and for several hours, searched the straws and stubble with the view of testing the possibility of the occurrence of a second brood of flaxseeds in the upper part of the straw,—the descendants of the flies emerging in May and June. None occurred in the upper joints, however, although they were still abundant at the bases of the straws.

On the 20th October of this year, the work of this fly was again evident at Robinson, larvæ occurring in three fields out of ten examined by my friend Mr. Moore.

As confirming the evidence from our breeding cages of the early hatching of a considerable percentage of the flaxseeds of the spring brood, I quote from a private letter from Mr. John Marten.* He says, "I have found but few of the spring brood of larvæ, as I wrote you in my last, and no flaxseeds; but on June 8, I found an adult female sticking in the oil on my lamp in my room. During the subsequent week I found four others on lamps. I was not well enough at the time to go to the fields, or I might possibly be able to report something more interesting now."

I append a tabular exhibit of the observations reported above in order to bring the details more clearly under the eye.

* Mr. Marten was for a long time assistant of Dr. Cyrus Thomas, my predecessor in the office of State Entomologist, and is in every way an intelligent and competent observer, thoroughly acquainted with the Hessian fly, in whose midst he has lived for years.

CALENDAR.

1883.

No.	Date.		Larvæ.	Flaxseeds.	Imagos.	Remarks.
1	April	10		Centralia	Centralia	Breeding Cage
2	"	14		Centralia	Centralia	Breeding Cage
3	May	5	DuQuoin			
4	"	17	Odin	Odin		
5	"	24	Decatur			
6	"	28			DuQuoin	Bred from No. 3
7	June	3		Macoupin Co.		
8	"	12		Granville		
9	"	4-15			DuQuoin	Bred from No. 3
10	"	26		Warsaw		
11	"	29		Godfrey		
12	"	30		Jerseyville		
13	July	4		DuQuoin		
14	"	7		Effingham		
15	"	9		Villa Ridge		
16	"	20		DuQuoin		Living larvæ
17	Aug.	5		DuQuoin		
18	"	7		DuQuoin		Living larvæ
19	Sept.	6		Centralia		Living larvæ
20	"	6			Centralia	
21	Dec.	—		Kansas		
22	"	9	Anna	Anna		
23	"	27		Albion		

1884.

24	Apr.	9		Marshall		
25	May	19	Albion			Just hatched
26	"	21		Marshall		
27	"	25	Robinson	Robinson		
8	"	26	Robinson	Robinson		
9	"	27	Mt. Carmel	Mt. Carmel		
0	"	30		Carmi		
31	"	31		Eldorado		
32	June	2	Robinson	Robinson		
33	"	3		West Union		
34	"	3		Villa Ridge		
35	"	4		Anna		

Calendar—Continued.

No.	Date.	Larva.	Flaxseeds.	Imago.	Remarks.
36	June 6..		DuQuoin		
37	" 7..		DuQuoin		
38	" 14..	Robinson	Robinson		Young
39	" 17..		Robinson		
40	" 17..			Villa Ridge	Bred from No. 34
41	" 18..		Anna		
42	" 20..			Villa Ridge	Bred from No. 34
43	" 20..		Robinson		
44	" 20..			Marshall	Bred from No. 26
45	" 22..			Anna	Bred from No. 35
46	" 22..			West Union	Bred from No. 33
47	" 24..		Robinson	Robinson	
48	" 24..		Anna		
49	" 25..		Marshall		Contained liv'g larvæ
50	" 27..		Robinson		
51	" 28..			Robinson	Bred from No. 47
52	" 28..			West Union	Bred from No. 33. Insects in copulo
53	" 30..		Robinson		Living larvæ
54	July 1..		Marshall		
55	" 5..		Marshall		
56	" 7..		Villa Ridge		Living larvæ
57	" 12..		Anna		
58	Oct. 20..	Robinson			

Although on a subject as difficult and important as that of the midsummer history of the Hessian fly it is probably best to await additional data before attempting to establish a final conclusion, it must be admitted that the facts above stated strongly suggest the hypothesis of a normal completion, before harvest, of the transformations of a considerable part of the destructive spring brood of the larvæ.

It is with a sense of disappointment that I make this statement, as this condition of things greatly diminishes the value of midsummer measures for the protection of our wheat fields, if it does not indeed render them almost wholly useless. While undoubtedly the burning of the stubble in the summer and other measures of the sort must destroy a considerable number of larvæ and pupæ, it seems possible that enough adult flies will have escaped before harvest to continue the species in scarcely diminished numbers.

It may be objected that the earliest imagos that escape from the spring brood of larvæ may immediately lay eggs, and thus give origin to an intercalated brood of larvæ which form flaxseeds before harvest,—perhaps in immature and stunted plants; but it was to this point above all others that our attention was especially given this year; plants of all ages, from infested fields, being examined by hundreds at a time, with almost microscopic thoroughness and care with the express purpose (and I may add the lively hope) of discovering such young larvæ. The results of all this labor were, however, absolutely negative. Not a single larva was found which it seemed at all possible to suppose could have descended from flies of later origin than those escaping from the flaxseeds which had spent the winter in the fields.

PARASITES.

Surprisingly little of a definite and accurate character has been published on the parasites of this interesting and important insect, and nearly all the facts now current have been derived from almost the first competent observer of the fly in America. The only species carefully described is *Semiotellus destructor*, first noticed by Say, and studied, as to its habits and life history, with some care by him, and especially by Prof. Herrick, of Yale College in 1833. One other parasite, *Platygaster error*, has been described by Fitch, but its life history has been only imperfectly worked out and inaccurately stated. A few other forms have been mentioned, without names or full descriptions, by Herrick, Fitch and Cook.

The data herein presented are in themselves very incomplete, but are as full and definite as I have been able to make them, with two years study, in respect to the life histories of the parasitic species found to affect the Hessian fly in Illinois in any important way.

The common *Semiotellus destructor* is here redescribed in detail and descriptions are given of three new species bred from infested wheat, and mention is made of two others not fully studied,—and for all these species I have given full abstract of our breeding cage records.

It is proper to say that, as my studies were made with principal reference to the life history of the Hessian fly itself, I was especially solicitous to depart as little as might be from the natural conditions of the species, and hence did not remove the flaxseeds from the straws, as would have been desirable for the breeding of the parasites only. From this it results that some of the parasitic species may have infested other wheat insects than the Hessian fly. Indeed, as *Eupelmus allyni* appeared quite frequently in these breeding cages, and as this species has been supposed to be parasitic on the wheat straw worm only, it is not impossible that some of our straws were inhabited by this last species also, and that some of the new parasites herein mentioned belong to Isosoma.*

Semiotellus destructor, Say.

Order HYMENOPTERA. Family CHALCIDIDÆ.

This is far the commonest of the parasites of the Hessian fly in Illinois, 85 per cent. of those appearing in our breeding cages (excluding Eupelmus) belonging to this species. It has been repeatedly described by Say, Fitch and Packard, but so imperfectly or inaccurately that I have not found it easy to identify the species positively. Not doubting, however, that our most abundant form belongs here, I give a fresh description of both sexes, carefully drawn from alcoholic specimens.

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*Prof. Riley writes me that he has repeatedly bred *Eupelmus allyni* from the Hessian fly.

DESCRIPTION.

Male.—A minute black bronzed insect, 1.9 mm. long, with the abdomen blotched with white at base.

Head bronzed greenish black, thickly coarsely punctured on all the exposed surfaces, convex before without frontal grooves, concave behind, .64 mm. wide by .68 mm. in vertical depth; eyes and ocelli dull red, the former oval in outline, the posterior margin more convex than the anterior, broadest above the middle, .27 mm. in vertical diameter, .15 mm. in antero-posterior: ocelli in a triangle on the vertex, lateral ones a little nearer to the eye than to each other.

Antennæ inserted below the middle of the front, 1.4 mm. long, 13-jointed, counting the minute third and fourth joints and not including a minutely rudimentary apical one; four basal joints yellow, remainder black, joints from the fifth to the tip densely clothed with erect black hairs, each segment with a ring of a few long appressed yellow hairs; the scape or first joint is about .3 mm. in length, second joint one-third that length, third and fourth minute, measuring together about .03 mm., visible only under a high power, the fifth measuring .11 mm. in length. The joints from the fifth to the tenth are slightly compressed, and gradually decrease in length; the eleventh, twelfth and thirteenth joints are more closely united, forming a cylindrical club with a pointed tip, the thirteenth joint being conical. The first joint of the club is about equal to the joint preceding. The minute apical process is about .06 mm. in length.

The thorax is .9 mm. in length, about half as wide in front as long, widest between bases of front wings, where it measures .63 mm. Color bronzed greenish black on all surfaces, densely coarsely punctured everywhere, like the head, and provided, as is the head, with scattered minute yellowish hairs. Thoracic sutures are deeply impressed. Prothorax with hind margin deeply concave, and sides with deep obliquely vertical grooves. Mesothorax with straight transverse sutures in front of the scutellum; parapsidal grooves extending half way to this transverse suture. Sides of mesothorax widely excavated obliquely forward and upward from the coxæ. Scutellum somewhat vaulted, narrowed forwards, postscutellum narrow. Mesonotum declivous, convex from side to side, dorsal outline nearly straight.

Wings coarsely hairy throughout; front wings 1.4 mm. long, .64 mm. wide at widest part, hind wings .1 mm. in length; stigmal branch of fore wing nearly as long as costal vein, expanded at tip; postcostal vein vanishing insensibly towards tip of wing. Very slight traces of median and submedian veins may be made out by close examination.

Legs slender, posterior pair longest, ends of tibiæ nearly attaining the tip of the abdomen; spurs of middle tibiæ stout, curved at tip, nearly as long as first joint of tarsi. Tarsi all similar, spinous beneath, first joint longest, others shortening to the fourth, the fifth about as long as the second. Tibiæ all white, tarsi white except

the last joint, which is dusky. All the femora more or less dusky, pale at each extremity; trochanters pale, the coxæ bronzed like the thorax.

Abdomen shining, impunctured, about 1.2 mm. long by .45 mm. wide, oval in outline, narrowing toward either extremity; seven distinctly visible segments, the first about as long as the two following, second short, seventh conical. General color of the abdomen piceous or bronzed black, first segment bronzed green at the extreme base with a quadrate yellow patch above, which sometimes extends on to the second. A similar but paler patch beneath, covers the first three or four ventral segments. All the segments are sparsely hairy upon the posterior half.

Female.—The female is extremely similar to the male, but may be distinguished at once by the abdomen and the antennæ, the former being more broadly ovate, more acutely pointed, and bearing a sting-like ovipositor beneath, usually indeed exserted at the tip. The color of the abdomen is darker, the pale area at the base being smaller, less definite and of a chestnut tint. The antennæ are pale throughout, somewhat shorter than those of the male, with the joints less hairy and more distinct. The club is pointed ovate, shorter than that of the male, and not distinguishable into separate joints, so that the recognizable segments in the female antennæ are eleven in number instead of thirteen, as in the male. The club is equal in length to the two joints preceding, the tip acuminate and slightly recurved.

LIFE HISTORY.

Our earliest* specimens of this species were obtained June 3 from Hessian fly larvæ, collected on that date at Villa Ridge, in extreme Southern Illinois. The earliest collection from which this parasite emerged was made on the 27th May at Mt. Carmel, the adult Semiotellus appearing on the 22d of the following month. The latest examples of this species to appear in our breeding cages emerged July 26, from flaxseeds collected on the 24th June at Anna, Illinois. Further details respecting the periods of this species will be found in the table at the end of this paper.

It is worthy of note that although our breeding cages containing straw and stubble infested by the Hessian fly were all reserved for more than a year, no examples of this parasite occurred therein in spring, although by Herrick it is reported to emerge at that time.

Pteromalus pallipes, n. s.

(Plate IV. Fig. 1.)

A short thick species with the head broader than the thorax, the abdomen ovate and obtuse. Head and thorax bronzed black,

* Although it has been heretofore supposed that the winter brood of the larvæ of the Hessian fly was never parasitized, I find among our breeding cage notes an entry to the effect that six living chalcid parasites were taken on the 10th May, 1883, from a cage in which multitudes of Hessian flies had been bred, the wheat containing them having been collected April 10, at Centralia, Ill.,—a date so early that only the winter brood of larvæ could possibly have occurred in it. I greatly regret that, owing to a removal of my office, I can not get access at this writing to the specimens on which this statement was based.

thickly set everywhere with punctures of medium size. The occiput and the dorsum of the thorax with a few scattered appressed hairs. The front of the head is vertically grooved for the long first joints of the antennæ. Eyes pale red, mouth parts brown. The antennæ are about as long as the head and the thorax, thirteen-jointed, the first joint pale yellow, second joint dusky, the remaining joints black. The first joint is about equal in length to the four following, the third short, that and fourth together shorter than the second and about equal to the fifth, the joints widening from the first to the fifth, (except the third which is not wider than the second), the following joints to the eleventh of about equal diameter, thence tapering rapidly, the last three not being clearly distinguished. The first joint is nearly smooth, the second somewhat hairy, all the others black-pubescent, each with a transverse ring of long appressed yellow bristles.

The meso-scutellum is broadly rounded behind, the sides with an irregular excavation, the meta-scutellum with an elevated margin and an evident median carina. The sides of the metathorax are densely clothed with long black hairs.

Wings transparent, veins dusky yellowish, the post-costal and stigmal of equal length, about two-thirds as long as the costal. Wing membrane sparsely pubescent, the veins with a row of stiff, erect black hairs. Patagia dusky yellowish.

The legs are pale yellow throughout, except the coxæ, which are of the body color. The abdomen is smooth and shining except the under sides of the three posterior segments which are pubescent. It is black above and piceous beneath, the edges of the segments being somewhat tinged with brown.

Length, 2.5 mm.; head, .95 mm. wide; thorax, .7 mm. by 1.06 mm. long; antennæ, 1.25 mm.; wing, 1.9 mm.

The specimens from which the above description was drawn, were all winged and were bred June 5, 1884, from flaxseeds and larvæ of the Hessian fly, obtained at DuQuoin, in Perry county, July 4, 1883.

The breeding cage from which these specimens emerged yielded no other parasites, but, when examined, were found to contain empty pupa cases punctured as if for the escape of parasitic insects, together with a few containing dried up larvæ.

Pteromalus ? fulvipes, n. s.

(Plate IV. Fig. 2.)

Under this head I describe, with some hesitancy, several specimens whose generic relations it is difficult to make out, owing to the fact that all the examples obtained were wingless. The essential resemblance to Pteromalus leads me, however, to place the species under that genus.

The head and thorax a dark bronzed green, and the abdomen above, dark steel-blue. The head is not grooved in front for the first joint of the antennæ, but is, like the thorax, thickly punctured

throughout, somewhat more coarsely so than in *P. pallipes*. The dorsal outline of the metascutellum is concave, the metathorax being nearly truncate posteriorly, owing to a tuberosity projecting from its upper posterior part. Metascutellum not margined or carinate. Antennæ eleven (thirteen) jointed, joints distinct except the third and the last three. In the female the first joint is pale yellow, the second dark fuscous, and the remaining joints black. All but the first thickly black pubescent, those beyond the second having each a circlet of long appressed hairs.

In the male the antennæ are pale yellow throughout, similar in appearance to those of the female, but with the last two joints closely united, forming a compact ovate club. In both sexes two minute sub-joints occur between the second and third joints. Wings in all the specimens seen rudimentary, legs pale, the coxæ, femora and upper half of the tibiæ, tawny yellow, the remainder of the leg being pale yellow, except the tip of the tarsus, which is dusky. Abdomen smooth, blue black above, lightening into piceous beneath, ovate, acute, in the female; smaller, obtuse, and more nearly oval in the male.

Total length 2.12 mm.; head, .7 mm. wide; thorax, .45 mm.; abdomen of female, .62 mm. by 1.05 mm.; antennæ, .82 mm.

This species appeared in our breeding cages of the Hessian fly during the months of June, July and August, in 1883 and 1884. Flaxseeds collected August 7, 1883, at DuQuoin, from stubble in the field, yielded the parasite August 17; parasites emerged June 21 from flaxseeds collected at Marshall on the 21st of May; those obtained at Robinson, in Clark county, May 25, emerged from the flaxseed June 20; and others obtained at Robinson, June 14, gave the parasites July 10.

Tetrastichus carinatus, n. s.

A slender, smooth, dark steel-blue species, 2 mm. in length, with pale legs, four-jointed tarsi and eight-jointed antennæ.

The head is very short, not wider than the somewhat slender thorax, impunctured, as are also the thorax and abdomen. Eyes large, dark red, broadly elliptical, occupying the whole longitudinal diameter of the head and even encroaching upon its posterior surface. Front broadly bisulcate for the reception of the scapes of the antennæ. Antennæ short, eight-jointed, joints very distinct, except those of the ovate club, (three in number), which are very closely compacted. Second joint shorter than the third, which is longer than fourth and fifth, these being subequal. First and second joints of the club nearly equal, thicker than the preceding. Flagellum of the antennæ pale, provided with a few erect black hairs, and long appressed yellow ones.

Prothorax is very short; the mesoscutum very long, narrowing posteriorly, when it is broadly truncate against the scutellum, regularly convex, minutely carinate longitudinally on the middle line; parapsidal grooves complete. Scutellum vaulted, with two longitudinal carinæ. Abdomen of female pointed ovate, broadest in front of the middle, somewhat flattened above.

Legs rather long, pale yellow; fore tarsi dusky, middle and hind tarsi dusky at tip; all the tarsi four-jointed, first joint of front and middle tarsi shorter or no longer than the second, that of hind tarsi longest of all.

The entire surface is very sparsely provided with coarse yellowish hairs, longest and most numerous at the tip of the abdomen.

Costal vein very stout, provided with unusually long hairs; stigmal vein short; postcostal nearly obsolete; no trace of median or submedian.

This species was bred with the preceding in our breeding cages from the collections made at Anna June 24.

As a summary exhibit of the facts concerning the life histories of the species above described, I append a table showing in detail the dates of collection and emergence for each, including also, for convenience sake, *Eupelmus allyni*, from the same breeding cages.

CALENDAR.

Semiotellus destructor.

Catalogue No.	Place of Collection.	Date of Collection.	Date of Emergence.
2353	Robinson	May 26, 1884	June 22, 1884
2350	Mt. Carmel	" 27, 1884	" 22, 1884
2361	West Union	June 3, 1884	" 28, 1884
2191	Villa Ridge	" 3, 1884	July 1, 1884
4259	Villa Ridge	" 3, 1884	June 3, 1884
2185	Anna	" 4, 1884	June 13—July 18, 1884
2349	Anna	" 6, 1884	June 22—July 10, 1884
2369	DuQuoin	" 7, 1884	June 20, 1884
4354	Anna	" 24, 1884	July 10–26, 1884
2370	Robinson	" 27, 1884	June 27, 1884
4349	Robinson	" 30, 1884	July 10, 1884
4356	Marshall	July 7, 1884	July 7, 1884

Pteromalus pallipes.

2200	DuQuoin	July 4, 1883	June 5, 1884

Pteromalus fulvipes.

2310	Marshall	May 21, 1884	June 21, 1884
2309	Robinson	May 25–6, 1884	June 20–1, 1884
4357	Robinson	June 14, 1884	July 10, 1884
4586	Marshall	June 25, 1884	July 26, 1884
3806	DuQuoin	Aug. 7, 1883	Aug. 17, 1883

Tetrastichus carinatus.

4358	Anna	June 24, 1884	July 10–26, 1884

Calendar—Continued.

EUPELMUS ALLYNI.

Catalogue No.	Place of Collection.	Date of Collection.	Date of Emergence.
2194....	Villa Ridge.....	June 3, 1884....	June 13—July 1, 1884.....
2185....	Anna	" 4, 1884....	" 13— " 18, 1884.....
2349....	Anna	" 6, 1884....	" 23— " 10, 1884.....
2269....	DuQuoin	" 7, 1884....	" 20, 1884 .....
4358....	Anna	" 24, 1884....	July 10–26, 1884, ...
4566....	Marshall	" 25, 1884....	" 26, 1884.....
4349....	Robinson	" 30, 1884....	" 10, 1884.....
4356....	Marshall.....	July 7, 1884....	" 7, 1884.....
3806....	DuQuoin	Aug. 7, 1883....	Aug. 17, 1883.....

As a general result of these observations, we may say that, with the single exception of *Pteromalus pallipes*, all the parasites bred by us from wheat containing the Hessian fly emerged before the August following the laying of the eggs from which they hatched, and that the former species survived the winter in the flaxseeds of the flies, not emerging until the succeeding summer.

4. NOTE ON THE WHEAT MIDGE.

(*Cecidomyia tritici*, Kirby.)

Order DIPTERA. Family CECIDOMYIDÆ.

(Plate IV. Fig. 3.)

This frightfully destructive enemy of wheat appeared during the last summer in extreme Northern Illinois in numbers and under circumstances to demand the attention of the economic entomologist; and although its life history and habits have long been well known, its occurrence in the West in numbers sufficient to attract attention has been so rare, that very little is known of it by the farmers of our State. It consequently seems best to give here a brief report of the observations made this summer in the wheat fields of McHenry county, together with a synopsis of its life history and such recommendations of remedial measures as are warranted by our present knowledge of the insect.

My attention was first called to its prevalence in that region by a letter, dated July 25, from Mr. R. W. Lane, of Chicago, who transmitted heads of wheat from Genesee Depot, Wisconsin, which I found to be seriously infested by the midge. Thinking it possible that the same insect was at work in adjacent parts of Illinois, I visited the fields of the Fox River valley from Elgin northward, on the 30th and 31st of that month. In every field but one which I entered in the vicinity of McHenry and Ringwood, where spring wheat only was raised, I found the midge larva upon the heads of wheat, usually in only here and there a blackened head. In some

fields, however, these damaged and shriveled heads were so numerous as to have apparently reduced the crop from ten to twenty-five per cent.; an injury which the farmers had noticed, but which none had been able to account for to their satisfaction, the presence of the midge having entirely escaped them. The heads upon which it occurred were those which had filled imperfectly—sometimes containing no plump kernels, and sometimes fairly well filled except at the tip of the ear.

From the account of its life history, given later, it will be seen that the midge was now near the end of its life above ground, and no doubt by far the greater part of those which had previously infested the wheat had already entered the earth. The wet weather of the preceding week had in fact supplied the conditions most favorable to this migration of the larvæ.

There were not, on an average, more than three or four midge larvæ to a head, and these were commonly found on the outside of the glume, only occasionally on the kernel within. The observations here given should at least serve to put the farmers of the northern part of the State on their watchful guard against this insect,—the most dreaded and destructive foe of spring wheat known to agriculture; and in the hope of making them personally acquainted with this enemy of their harvests, I append here a sufficient description and figures to enable the reader to recognize the insect in its various stages, and such an account of its life history as will justify the recommendations made for the limitation of its increase.

DESCRIPTION.

Egg.—The eggs, as laid upon the wheat, are scarcely more than a hundredth of an inch in length, about one-sixth as thick as long, of a long oval form, very nearly cylindrical, with rounded ends. Their surface is smooth and shining, and they are almost colorless-watery, with a faint tinge of pale red. When several are together, in a mass, they appear of a deeper reddish yellow color.

Larva.—The larvæ are, at first, less than a hundredth of an inch long, resembling the egg closely, from which, however, they may be certainly distinguished by the fine transverse lines separating the segments. When under examination the larva is usually quiescent unless placed in water, when it immediately awakes from its seeming sleep. When wet and in motion (alternate contraction and elongation) several parts of its structure not perceptible before are plainly visible.

The quiescent larva is about three times as long as broad, measuring .08 in. by .03 in., and is oval, thickest in the middle and slightly tapering in each direction, the ends being rounded or but faintly angular-pointed. It is slightly depressed and on the under side very perceptibly flattened, but with no indications of feet. Its surface is minutely granular, like that of the common earth worm of our gardens, and also appears to be slightly coated over with a glutinous secretion, whereby it adheres to a needle which touches it, and often when two or more worms are placed in contact they in dying become glued to each other. Its joints are indicated by very fine im-

pressed transverse lines, whereby it is divided into ten or twelve segments of equal length, except at the ends where it is difficult to definitelv distinguish them. It is of a rich yellow color varying in different individuals from lemon to orange-yellow, and usually a small greenish or blackish cloud is seen placed lengthwise in the middle of the body on its under side, which is evidently caused by internal alimentary matter.

The moving larva is of a more elongated and elliptic form, tapering to an acute point at its fore end and much more blunt behind. Thirteen segments are now plainly to be seen. Of these the three first and the last have a smooth surface and are whitish and semi-transparent, only the nine intervening ones being yellow and with their surface granulated. Each segment is fringed at its end with a row of small hairs like eyelashes, which are continued along the whole length of the edge. The head is conical, longer than broad, tapering to an acute point in front, and has a depression on each side near the middle where is inserted a short thread-like process, forming with its fellow a pair of horns, which are articulated at their bases. The last segment is cut off transversely in a straight line; but as the worm crawls, when it draws the hind part of its body forward with each step it takes, this hind end becomes strongly concave. When the worm is dry and endeavoring to crawl on a dry surface, this end of its body becomes wholly different. It is then strongly concave, its angles acute and tooth-like, with two similar teeth between them which may be of the same size or retracted, showing their points only. On each side of this last segment a rounded tubercle is sometimes protruded from beneath, bearing a conical point and resembling a proleg. Under the same circumstances the head is wholly retracted, leaving only the ends of its horns visible.

Puva.—The cocoons in which the larvæ enclose themselves resemble little round grains smaller than a mustard seed. When coated with dirt, as they usually are, it is almost impossible to discover these cocoons even with the aid of a magnifying glass. The naked larvæ that are sometimes found in the earth in the spring are doubtless those which remained in the wheat after its harvesting.

Imago.—The following remarks condensed from Fitch's Report will constitute a sufficient description of the imago to enable the intelligent observer to recognize it, especially when taken in connection with the figures, copied on a larger scale from Fitch's plate.

The individuals of this species differ so widely as to color, size, and perfection of organs and members, that no study of these points will enable one to distinguish this fly from other species when specimens are gathered in other situations than on wheat. We can then recognize it only when it shows the following essential characters:

'The body nearly one-tenth of an inch long, bright orange or lemon-yellow, and tarnished or slightly smoky on the back, forward of the wings; the wings clear and glassy and having a small cross vein near their base; the antennæ about as long as the body and composed of twelve oblong joints which are narrower in their middles and separated by short pedicels.

We are assured a midge-fly is this species when it possesses all these characters. But many flies also pertain to this species which do not fully possess them, some departing from the standard in one, others in another particular, whereby it happens that no one of these characters is constant and found in all the members of this species. All the bright yellow midges which occur in our wheat fields during the latter half of June may be regarded as the wheat midge.

LIFE HISTORY.

The fly or perfect insect makes its appearance in ordinary seasons a little before the middle of June, in the latitude of New York, but its hatching varies with the latitude and the progress of vegetation. A warm season hastens, a cold season retards insects and vegetation alike. Under ordinary circumstances this fly lives about three weeks, but if the season be wet and the fly numerous it is seen abroad much longer, sometimes until the middle of August. Moisture is its life, dryness smothers and suffocates it, consequently it cannot remain upon the wheat heads during the heat of the day, but rests upon the lower part of the stalks until the sun begins to decline, when it returns to its operations upon the heads. On damp cloudy days the insect is as active in the day as at night, and spots shaded by trees, or wheat on low lands, are the most severely injured. If at the time the fly is abroad, depositing its eggs, the weather be extremely dry, the crop escapes; if unusually wet weather prevails, the grain will be severely injured.

In the deposition of its eggs the only aim of the fly seems to be to place them in some crevice of the headlet where they will be comparatively secure from enemies, and sheltered from the sun and air, which would shrivel them. From the form and character of the ovipositor it is evident that the fly is restricted to crevices for the deposit of its eggs. They are, perhaps, most commonly placed in the little orifice at the summit of the outermost chaff, but may be found in any narrow opening upon the headlets which the fly is able to discover. Sometimes a single egg is found, but they are usually in clusters of from two to ten. The young larvæ appear in about a week after the egg is laid. In whatever situation hatched, they must find their way at once to the germ or kernel from which they derive sustenance. Attaching themselves first at the base of the kernel they afterwards, as they increase in size, usually withdraw farther up the side. The larvæ mature in about three weeks and may often be seen descending to the ground as early as July 11, while some of the parent flies are still depositing their eggs. Some of the larvæ throw themselves to the earth with a skip from the beards; others crawl down enveloped in a pellicle of water; and still others crawl in a serpentine track till the globule of water in which the larva is moving becomes so large that it is upon the point of running down the straw, when the larva lets go its hold, and is carried to the earth.

It is a mistake to suppose that only the larvæ which go into the ground before harvest live and produce the flies of the following year. Experiments indicate that few if any of the larvæ would be

dead at the end of even six months. Their vitality is astonishing. No extremity of hunger or thirst seems to kill them and water does not drown them. They are perfectly amphibious.

INJURIES TO GRAIN.

This insect effects its injury by sucking the milky juice from the young kernel, without any apparent gnawing of the surface, thus causing the grain to shrivel and blight, the heads remaining substantially unfilled. Not unfrequently the crop is utterly ruined, and the loss in whole states, like New York and Ohio, has occasionally reached a total of two-thirds or three-fourths the entire average yield.

REMEDIES.

No application of remedial or preventive measures has hitherto arrested the ravages of the midge, although it is not impossible that they have somewhat mitigated the gravity of its attack. The only ones hitherto suggested which even promise usefulness are those of destroying the screenings of the mill when the wheat is threshed and cleaned immediately after harvest; or, for the purpose of getting rid of the midge larvæ remaining on the grain, that of deep plowing of the old fields of wheat with the hope that the larvæ remaining in the ground may thus be buried beyond the hope of resurrection, when their transformations are completed the following year.

Besides these, we have the heroic remedy of refraining from the cultivation of wheat where the success of the crop is threatened by the previous appearance of the midge,—doubtless the most effective measure provided it be generally adopted.

5. The Wheat Bulb Worm.

(*Meromyza americana*, Fitch.)

Order Diptera. Family Oscinidæ.

(Plate IV. Figs. 4-9.)

Since the outbreak of this insect in Fulton county, described in my report for last year, it seems to have entirely disappeared from that locality, not a single field, this year, having given the slightest evidence of its presence; a fact doubtless due to the destruction effected by the parasite described by me in the article above mentioned.

Indeed, in all our observations and collections made in different parts of the State during the past season, no evidence was seen of anything more than trivial injury by this insect until late in October, when Mr. N. S. King, of Normal, called my attention to a field of rye which had been mysteriously checked in its growth and seemed likely to be entirely ruined. An examination of this field made on

the 31st October showed that the outer stalks of nearly every stool were dead, although, owing to the recent rains, new leaves were being sent up from the center of the stool. The stand was light upon the ground, but the owner reported that it had been excellent at first. On examination, the greater part of the dead stalks were found to harbor the larvæ of Meromyza about half grown. When taken from the stalks these larvæ traveled with considerable activity, using their mouthhooks to draw themselves forward.

This field of rye was sown unusually early (July 9) for pasture, a fact entirely consistent with respect to the conditions favorable to injury by this pest. Late sowing remains the only preventive measure against it.

6. The Grass Worm or Fall Army Worm.

(*Laphygma frugiperda*, Guen.)

Order Lepidoptera. Family Noctuidæ.

(Plate V. Figs. 1 and 2.)

An abundant southern insect well known in fields of cotton and corn in the Southern States, but rarely noted in Illinois, has twice appeared in this latitude in numbers so extraordinary as to attract general attention and to do very considerable mischief in fields of young winter wheat in autumn, and once in corn fields in midsummer. It first appeared here fifteen years ago, and has since been seen only by entomological collectors, until the autumn of the present year. Its occurrence was first announced to me on the 2d October by Mr. H. C. McIntire, of Topeka, Tazewell county, who wrote:

"I have this day mailed you a box containing specimens of a worm that is devastating wheat fields in this part of our county. They hatch on land that was in oats this last year, and they are eating the wheat clean. Hundred of acres in this part of the county are as clean at it is possible for land to be, not a green thing left. From land that was in oats, they go to wheat that was in wheat last, eating it clean as they go."

Two days later, Mr. F. E. Buckley, of Tremont, wrote me:

"There is a worm working in the winter wheat in this section, which is causing much consternation among the farmers. Many call it the army worm. In a field of wheat of twenty acres, visited by the writer this morning, this pest could be seen working in large numbers. Throughout the entire field there were probably on an average, from a dozen to a dozen and a half worms to the square foot; worms from one-fourth to one-half inch in length to full grown ones. A full grown one is about one and a half inches in length. They seemed to have entered my wheat from an adjoining corn field on the north, and are working towards the south. In many places the oats is quite thick, as the wheat was sown upon oats stubble. But the worms do not touch the oats. They cut the wheat off close to the ground and eat it up clean, or else climb the spears and eat it down."

On the 9th I visited Tremont, and saw the species at work in the wheat fields, although it had at this time nearly closed its career for the season, by far the greater part of the brood having entered the earth for pupation. On the 10th and 11th, an assistant, Mr. C. A. Hart, made a trip through the fields of Tazewell and Mason counties, carefully observing the insect in the field and collecting specimens for the breeding cages.

LITERATURE.

This species was first described by Smith and Abbott, in their "Rarer Lepidopterous Insects of Georgia," in 1797, under the name of *Phalæna frugiperda*. Its character as an injurious agricultural insect was first observed in the Southern States.

In a description of the imago and larvæ by Guenée, in his work on Noctuelites, Vol. I, p. 159, published at Paris in 1852, the general distribution of the moth of the grass worm is given, as known at that time.

In the Patent Office Report for 1855, is an article by Townend Glover on Cotton Insects, containing a somewhat extended account of this species under the title of "grass worm" or "grass caterpillar," but without scientific name. A description of the larva and moth are given, and figures of these and also of the chrysalis. A valuable account of the habits of the larvæ in Georgia, of their injuries to vegetation, and of their destruction by ants is also given in this article.

The earliest notice of the occurrence of this species in the Valley of the Mississippi with which I am acquainted, is contained in the first report of Mr. C. V. Riley, as State Entomologist of Missouri [1868]. On page 87 of this report he mentions the injuries to wheat due to this insect, (especially to wheat sown upon oat stubble), and makes some suggestions of preventive measures against its attacks in future. The farmers of this region, however, reported to him that the same insect had been known to attack the wheat in the fall, for many years previous. Mr. Riley uses no technical name in this article, but calls the larva the "wheat cutworm."

The earliest mention of its occurrence as an injurious species in Illinois, was made by Walsh and Riley, who in a paper on the boll worm or corn worm (*Heliothis armigera*), published in the American Entomologist for November, 1869 (Vol. II, p. 42) report having received our species from Tuscola, in Central Illinois. Not recognizing it, they regarded it as a new species of Prodenia, and proposed for it the name *Prodenia daggyi*. They reported it as feeding externally upon the leaves of corn, and likewise eating into the heart of the young plant.

On page 328 of the same volume, Riley reports the receipt from many parts of Missouri and Illinois of the "fall army worm," its injuries being most marked in the northeastern part of Missouri. He here distinguishes the species from the true army worm, adds several plants to its dietary, and doubtfully identifies it with the species previously called by him the "wheat cutworm."

Following this, on page 363, in the number for December, 1870, occurs a long article upon this insect, which is there called the "fall army worm," and described and discussed as *Prodenia autumnalis* n. s. The moth and larva are figured and very fully described, a brief description being also given of the pupa. Two varieties of the imago are distinguished and described as *fulvosa* and *obscura*; the occurrence of the worm in destructive numbers during that season in many parts of Kansas, Illinois and Missouri is noted; comparison of its characters and habits with those of the common army worm is made at length, the probable number of its broods and other points in its life history are discussed, and an account is given of its habits of oviposition, and a description of the egg. In Riley's second report, page 41, this species is referred to as *Laphygma frugiperda* of Smith and Abbott, but evidently not identified by the writer with the "wheat cutworm" of his previous report.

In his third report, that for 1870, Riley again recurs to the subject, treating the grass worm at length, but now under the name of *Prodenia autumnalis*. This article is substantially the same as that already mentioned, published in the Entomologist and Botanist for December 1870, but with some additional details with respect to its injuries to vegetation in Missouri and also concerning its life history and parasites.

These observations of Riley are referred to next in the report of the United States Department of Agriculture for 1871, but no additional particulars are there given; and in the report for 1872 of this series the occurrence is recorded of the "grass army worm," as it is called, in Georgia, in destructive numbers, devouring corn, grass, and pea crops.

In the Eighth Annual Report of the State Entomologist of Missouri page 48, Mr. Riley again refers to it in an article on the true army worm, and in a foot note concedes the identity of the species with the *Phalæna frugiperda* of Smith and Abbott and the *Laphygma fruqiperda* of Guenée.

The "grass army worm" is first mentioned in the Illinois Reports in the seventh of the series, pages 97 and 219, in a brief article by Prof. Thomas, compiled chiefly from previously published notices, but containing some additional particulars respecting its life history in that part of Central Illinois where it was first observed.

Mention of its carnivorous habit under peculiar circumstances as reported by Mr. Glover in the Report of the Department of Agricultural for 1855, (p. 100) is made in Prof. Comstock's elaborate report upon Cotton Insects published by the United States Department of Agriculture in 1879.

I have also seen a brief notice of its occurrence in cotton fields, in Bulletin No. 3, of the United States Entomological Commission, where its is barely mentioned as sometimes very abundant in cotton fields and likely to be mistaken for the true cotton worm (Aletia.)

In the American Entomologist for January, 1880, advanced sheets of the above article were printed containing the same notice.

In the Tenth Report from this office, a brief paragraph containing no new information is devoted to this species. In the Report of the Entomologist of the United States Department of Agriculture printed in the Report of the Department for 1881 and 1882, Mr. Riley speaks of this species while discussing insect injuries to growing rice, noting its occasional injury to that plant, and making suggestions for the arrest of its ravages when they become serious. In Mr. J. A. Lintner's First Report as State Entomologist of New York (1882), the grass worm is simply included in a list of species injurious to the apple.

NOMENCLATURE.

This insect, as already remarked, was first described under the name of *Phalæna frugiperda*, and has since received the scientific names of *Prodenia daggyi*, Riley; *Prodenia autumnalis*, Riley; and *Laphygma frugiperda*, usually incorrectly printed *Laphrygma* in the articles of Walsh and Riley.)

Its common names have been equally numerous. The prevalent one in the Southern States is, apparently, the "grass worm" or "grass caterpillar," while to the northward it has been, perhaps more generally, called the "fall army worm." Riley first gave to it the name of wheat cutworm, and by many it is erroneously styled the "army worm," on the supposition that it is the fall brood of that far more common and destructive pest. In order to avoid this erroneous association of our species with the common army worm, it seems to me decidedly best that the name of *fall army worm* should be dropped and that of *grass worm* be commonly used instead.

DESCRIPTION.

Imago.—Front wings narrow, apex broadly rounded. General color brownish grey, varied with bluish white, dusky and fulvous. A bluish white patch at the apex of the wing, usually containing a few black points. Subterminal line arcuate, of the same color, continuous with this patch in front, sometimes obsolete at the terminal angle of the wing, but sometimes complete. Before the subterminal line and within the apical patch is a dark blotch upon the middle of the wing, which sometimes contains one or two triangular black points. Transverse anterior and transverse posterior lines sometimes obsolete, when present, double, zigzag. Base of wing slightly paler, with a longitudinal black blotch in the middle. Orbicular spot obliquely oval, pale testaceous, with an oblique mark of same color immediately without. Reniform spot obscure, distinguished in front and behind by small whitish blotches, the posterior linear, often shaped like the letter *e*, the anterior variable. Upon the costal margin, a series of whitish dashes, four of them between the reniform spot and the apex, and as many more, obsolete, between that and the base. Terminal line pale, subterminal space dark, divided into quadrate blotches by the nervures. Fringe paler gray, the scales tipped with black between the nervures. Under surface

smoky but paler anteriorly and terminally and fulvous along the costa. Posterior wings translucent, nearly white in some lights, roseate in others, dusky on anterior margin and on anterior half of outer margin. Head, thorax, and abdomen, nearly uniform gray; thorax with a V-shaped black mark in front.

Larva.—The larvæ collected this autumn were dark, the general effect being that of a nearly black insect with a broad buff band below the stigmata, and a narrow yellow subdorsal line. The dorsum is black or a very dark brown with a yellow median line, and irregular white lineations along the border of the dorsal space. The subdorsal band is also black, slightly mottled along the lower margin, bordered above by a yellow line which is itself bordered above and below by a shade of deeper black. The stigmatal band is drab, mottled with pale brown; the stigmata black, partly within the substigmatal band and partly within the subdorsal band. In one specimen, the dorsum is pale chocolate brown with scarcely a trace of the median line. The heads in all are jet black except on the sides, behind the eyes, where they are somewhat mottled with whitish. The Y-shaped mark upon the front is white and deeply impressed. The cervical shield is black, with the median line and subdorsal yellow lines continued upon it. Upon the caudal shield the median line widens to a more or less triangular blotch. The labrum is brown, the basal joint of the antennæ is wholly white, the second joint white with a black ring at the base, and the third joint brown. The venter is greenish brown beneath the buff lateral band, becoming nearly yellow towards the bases of the prolegs. Each of the latter has a glossy black patch upon its outer surface. Between these legs the surface is a brownish green. The whole ventral area is finely mottled with yellow.*

DISTRIBUTION.

By Guenée, this species is reported to occur in North and South America, and likewise to have been received by him from Tasmania.

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*The following is the description of the larva and pupa of this species given by Mr. Riley, on page 117 of his Third Report as State Entomologist of Missouri:

Larva.—Ground color very variable, generally dark and pitchy black when young, but varying after the last mouit from pale brown to pale dirty green, with more or less pink or yellow admixed—all the markings produced by fine, more or less intense, brown, crimson, and yellow mottlings. Dorsum brownish with a narrow line down the middle, rendered conspicuous by a darker shade each side of it. A dark, subdorsal band one-third as wide as each joint is long; darkest at its upper edge, where it is bordered and distinctly separated from dorsum by a yellow line which, except on joint 11, where it deflects a little upwards, is quite straight; paler in the middle of each joint. A pale, either buff or flesh colored substigmatal band, bordered above and below by a narrow, yellow and wavy line. Venter pale. Head pale yellowish brown, with sometimes a tinge of green or pink; the triangular piece yellowish, the Y-mark distinct and white, the cheeks with four more or less distinct lateral brown lines and with dark brown mottlings and nettings, which become confluent and form a dark curved mark at the submargin behind the prongs and each side of the stem of the Y. Stigmata large, brown, with a pale annulation, and just within the lower edge of the dark subdorsal band. Legs either light or dark. Cervical shield darker than body with the narrow dorsal and subdorsal lines extending conspicuously through it; anal plate also dark, narrow and margined by the pale subdorsal lines—both plates furnishing stiff hairs, but without tubercles. Piliferous tubercles on joints 2 and 3, arranged in a transverse row, and quite large, especially on joint 2; on joints 4–10 the superior eight are arranged as follows: 4 in a trapezoid in dorsal space, the posterior two as far again from each other as the anterior two, and two near the stigmata, one above and one behind; on joint 11 the dorsal 4 are in a square, and on joint 12 in a trapezoid, with the posterior and not the anterior ones nearest together; the thoracic joints have each a large subventral tubercle just above the legs. Length 1.10–1.50 inch. Described from numerous specimens.

Pupa.—Formed in the ground, without cocoon; of normal form, bright mahogany-brown, and with a distinct forked point at extremity.

It seems to be abundant throughout the Southern States, but I do not know of its occurrence north of the latitude of Central Illinois. The destructive outbreaks which I have encountered in my reading on this species, occurred as follows: In 1845 and 1854, in Georgia; 1868, in Central Illinois and Northeastern Missouri; 1870, Kansas, Illinois and Missouri; 1872, Central Georgia; 1873, Washington county, Illinois; and 1881, in Georgia.

In Illinois, this autumn, we found it generally distributed in destructive numbers throughout the eastern two-thirds of Tazewell county and all of Mason county. From D. S. Harris, of Cuba, in Fulton county, and from Dr. R. Boyer, at Lewiston, I heard that it had generally prevailed in that county. Letters from Menard, Mason, Macon and Madison counties to the east and south, and from Stark on the north, reported no occurrence of the worm in those regions, and fixed the limit of the outbreak in those directions; but to the west it extended to the Mississippi river, having been reported by correspondents in both Pike and Hancock counties. The area infested was therefore a triangular one, the apex of the triangle being near eastern McLean county, and the base extending along the Mississippi from Pike to Hancock.

LIFE HISTORY.

In 1854, the caterpillars were abundant in Georgia during the last days of September and the beginning of October. "When about to change," says Glover, "they formed cocoons of silk under stones or in the ground near the surface, interwoven with particles of earth, and came out perfect moths from the 24th to the 30th of October; and, as these specimens were kept in a room without artificial heat, I conjectured that those in the open field would appear about the same time." They were also believed to have injured the rice in that State in June of the same year.

In Missouri, in 1868, the larvæ were received by Riley on the 10th of October. They came to their growth the latter part of October and entered the earth, where Riley believed that they would pass the winter in the chrysalis state.

In 1869, Walsh and Riley received specimens from Central Illinois in July, and the moths made their appearance towards the end of the same month.

In 1870, Riley expressed the opinion that there are at least two broods, and probably three or four in a year. "Those worms which appeared," he says, "in such multitudes in August and the fore part of September, in due time produced moths, and these gave birth to a new generation of worms, which began to make their presence manifest towards the end of October. And it will be remembered that, as stated in our last number, we bred the moth as early as July, in 1868, from worms received from Mr. Daggy."

In the above year they were noted in Central Missouri on the 26th of August. In 1881 they occurred on the rice in Georgia, in May, going into the ground for their transformation in the first and second weeks in June; and a later brood occurred in August.

During the present autumn they were first noticed by our correspondents during the third or fourth week of September, at which time

most seemed about half grown; but by October 10 the greater part of them were already in the ground, where most of them still continue. Few pupæ occurred at this time, most being in the shortened, prepupal stage. From the larvæ bred in the laboratory, collected from wheat fields October 11 and kept in a room without artificial heat, three moths emerged November 8, three more November 12, and another between that date and the 28th. The remainder are still alive in the earth as pupæ, at the present writing (December).

The pupæ in the field were usually buried from one to two inches beneath the surface, erect or inclined, in smooth-walled earthen cells. Not a few had only partly hidden themselves before the necessities of metamorphosis overtook them.

From the above data it is not easy to construct any consistent calendar of this species, the statement made by Riley in the Entomologist and Botanist for December 1870, seeming to conflict with the other observations reported. The larvæ occurring that year in "August and the fore part of September" in Missouri, if they really gave origin to a second brood, which "began to make their presence manifest towards the end of October," must have produced the imagos late in September and early in October,—that is at the very period when the brood of larvæ observed by us this fall were completing their growth and entering the ground for pupation, not to emerge until spring. In fact, the statement above quoted seems inconsistent with Riley's own report of his observations for 1868, when larvæ received October 10, entered the ground later in the month, and were believed to hibernate as pupæ, pupation in 1868 thus being made synchronous with the occurrence of growing larvæ of a later brood in 1870. As Riley rests the above cited report for 1870 on no precise data, but makes it only as a general statement, it is perhaps not impossible that it involves an error of inference. More probably, however, it represents exceptional conditions. If we thus exclude it either as irreconcilable with observed facts, or as an unusual occurrence, we have left self-consistent proof of three broods at the South and of at least two, and possibly three, as far to the north as Central Illinois. The larvæ of the first of these appears in May and June, pupating in the latter month and in July, and giving the imago late in this month. A second brood of worms occurs in the South in August, and a third late in September and early in October. The last corresponds to the observations in Illinois this autumn, and probably hibernates as pupæ, with scattering escapes of autumnal imagos, such as have occurred in our own breeding cages this year.

CHARACTER AND EXTENT OF INJURIES TO VEGETATION.

As far back as 1845, this species was reported to attack corn, sugar cane, and upland rice.

In Georgia, in 1854, the grass worms devoured grass, young grain, and almost every green thing which came in their path.

"Instances have been known," says Mr. Glover, "in which, urged as they were by necessity and starvation, they actually devoured stacks of odder that were stored away for winter consumption.

Deep ditches cut in the earth to stop them were immediately filled up by the multitudes which fell in and perished, while eager millions still rushed over the trembling and half-living bridge, formed by the bodies of their late companions, bent on their mission of destruction and devastation.

* * * * When pressed by necessity, however, as has already been stated, they will feed upon cotton leaves. I raised about thirty of them upon this food alone, merely as an experiment, and they grew and perfected their transformations, although appearing to prefer a grass diet if it could be obtained."

In Missouri, in 1868, they destroyed much young wheat sowed on oats ground, but did not trouble wheat sowed in the same fields on wheat stubble. They were here found to feed with equal relish on the young plants of both oats and wheat, and a variety of grasses.

In Illinois, in 1870, they fed in July upon the young corn, devouring the leaves, eating into the heart of the young plant, and, later, boring large holes through the ears, burrowing them in all directions. They were also reported to Mr. Riley to feed upon the leaves of the peach and apple, upon the under sides of which the imagos laid their eggs. If these were deposited upon other trees, like the sycamore, the larvæ, when they hatched, instead of eating the leaves, descended from the trees to feed upon more succulent herbage below.

According to the observations in wheat fields reported for 1863, wheat which had been completely eaten up was not necessarily ruined, some that had thus been cut off in the fall making a good stand the next spring, in one instance, at least, being even better than that which had not been touched.

[On the other hand, Mr. F. E. Buckley, of Tremont, who was the first to report the occurrence of these larvæ to me this fall, writes me this spring that the wheat eaten off was almost invariably destroyed and did not rally again. "On my piece containing twenty acres," he says, "one-third of the ground was bare. Wherever the worms worked, the wheat is killed and did not come up again; and in other instances I know of in this vicinity, the result was the same. One piece of about ten acres sown on very rich ground (oat stubble, of course,) which was completely destroyed, does not show half an acre of living grain."]

In Missouri, the worms have also been reported to destroy turnips, and buckwheat as it was just coming into bloom; while meadows were so ravaged that nineteen-twentieths of the grass was considered entirely killed. Oats and timothy were among the crops destroyed by them, the former being devoured when it had reached a height of six inches. Corn silks and soft corn were likewise eaten. Corn fodder, tomatoes, rye, potatoes, and cucumbers have been destroyed by them in various parts of Missouri, and in some vineyards they did great damage by gnawing around the stems and causing the bunches to drop off.

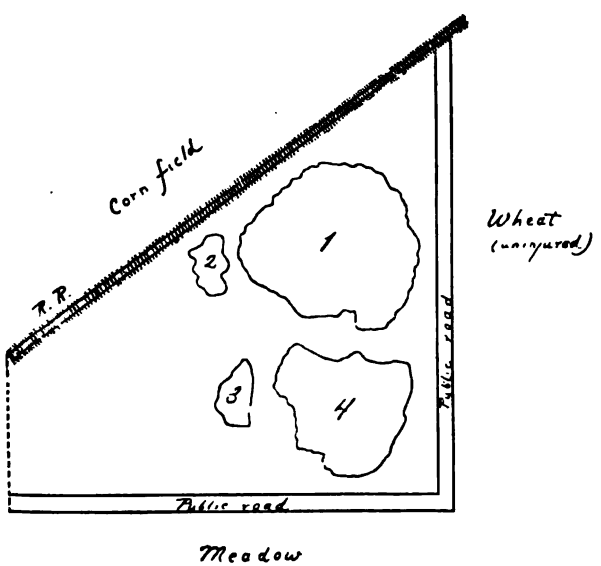
In corn fields, they were said by a correspondent of Mr. Riley's, not only to devour greedily the leaves and stems, but to bore large holes through the ears, burrowing them in all directions. In Georgia, in 1872, besides devouring corn and grass, they destroyed the

pea crop in some localities. The following year they made havoc with the winter wheat in Washington county, Illinois, in September, devouring the plants when they were two or three inches high; and some small damage was also done to corn. In Mr. Riley's report for 1881 and 1 82, the first and second generations are said to lay their eggs on the growing stalks of rice. The worms, hatching, "rag" the plants badly, and when in great numbers eat them to the ground. Grass, cabbage, strawberries, and beans were among the plants injured in Georgia during this year by a later brood.

In Central Illinois, this fall, the injuries were confined, as far as our observation extended, to old oats ground, with the exception of a field or two formerly in wheat, on which volunteer grain had sprung up in extraordinary quantity. We could hear of no damage noticed in the fields of oats early in the season on ground afterwards visited by the grass worm when cropped in wheat. In very many cases the loss was total, and many thousand acres of winter wheat were entirely killed by the worms in the area infested this year. Most of the fields were plowed and resown, but occasionally one was left. The destruction of a whole field was rarely complete, the bare area being usually in bands and patches, in the center of which the plants were eaten to the ground, while around the margins the damage was less severe. Where the wheat was early sown and had reached a height of five or six inches, stubs of an inch or more were left by the worms, and from these the plant partly revived.

The number of worms in a field, as indicated by the pupæ discoverable in the ground, was about six to ten to a square foot; although some farmers asserted that a handful could have been gathered, earlier, in their fields by a single sweep of the hand.

From Mr. Harris, of Cuba, I have received the following detailed account of the method and amount of the injury done in a field under his observation:



"I send you a rough sketch of a field infested by the grass worm last fall. I visited this field five times after the worms made their appearance, the first visit being about October 1, and the last one about December 6.

Upon my first visit to this field I found the worms actively at work in the spots marked 1, 2, 3, 4, they having seemingly begun at the center of the spaces and worked in all directions. Upon my second visit, the worms had eaten every green thing in space 1, over an area of six or seven acres, and many of them had entered the ground to pupate. In space 2 and 3 they had eaten about one half of the wheat, making it look ragged and thin on the ground. (The spaces indicated as 2 and 3 were about one half acre each.)

In space 4, they had destroyed all the wheat at the center, but had not extended their ravages so far as in No. 1, probably not more than half an acre being entirely eaten off, while about three acres was partially eaten, less damage being done as the boundary was approached.

At this time (second visit), I found more worms at work in No. 4 than in No. 1, but they were scattered over a relatively larger space.

When I returned on my third visit, about Nov. 7, I found No. 1 had been resown with the drill without plowing, while the other infested spaces had not been resown.

These parts of the field presented a yellowish, sickly appearance, and did not recover at all before cold weather. The leaves began to turn brown at the tips and dry up, while there was very little if any growth from the center. Even where the wheat was but little eaten by the worms, it presented a stunted appearance. The worms climbed upon the blades of the wheat and ate them, instead of cutting off the plant at the ground, so there was but little damaged except that actually consumed. But the ravages of this worm are greater than can be accounted for by the actual amount of the herbage eaten. They seem to produce an effect similar to that produced by a too free use of fertilizers upon growing plants.

This field of wheat was sown upon oats stubble plowed under without burning."

Natural enemies.

In the Southern States where the common species of ants seem to be much more predaceous and ferocious in their habits than with us, they apparently interpose a notable check on the multiplication of the grass worm.

"At a plantation in the vicinity of Columbus," in Georgia, says Glover, "where the caterpillars were very numerous, and had already devoured all the grass on one side of a field which was divided into two equal parts by a broad and sandy carriage road passing through the center of it, the grass on the other side having been untouched, it was interesting to observe the operations of numerous colonies of ants that had formed their holes or nests in the road, and were lying in wait for any unfortunate grass worm, the natural desire of

which for a fresh supply of food, should tempt it to cross this dangerous path. First one ant more vigilant than the rest would rush to the attack; then another, and another, until the poor caterpillar, entirely covered by its pigmy foes, and completely exhausted in strength by its unavailable efforts to escape, was finally obliged to succumb to superior numbers and die as quietly as possible, when the carcass was immediately carried off by the captors to their nests, or, when too heavy to be dragged away at once, they fed upon it as it lay in the road. This warfare was carried on every day as long as the grass worms prevailed, and no doubt their numbers were diminished in this way to a considerable extent."

By Riley the occurrence of considerable numbers of a Tachina parasite was noted in 1870; and we, ourselves, noticed the eggs of such a parasite this fall on at least fifty per cent. of the worms collected by us, most commonly fastened near the head. The imago of one of these parasites emerged in a breeding cage on the 28th November, and believing it new, I sent it to Dr. Williston, of New Haven, Connecticut, who, at my request, kindly furnished me the following description:

Exorista infesta, sp. n., Williston.

"*Female.* Palpi reddish yellow at the tip; third joint of the antennæ about thrice as long as the second; a single row of bristles extends from the front a little ways on the sides of the face above; the bristles of the face below do not reach the middle; legs black; scutellum yellowish, the tip of the abdomen reddish yellow. Length 6–7 mm.

Black. Face grayish white; on each side of the lower part of the face in front there are but three or four minute bristles above the large marginal bristle. Antennæ black, the third joint about three times as long as the second, of nearly equal width, straight on its front margin. Front light ochraceous on the sides, in the middle with a rather broad, parallel, opaque black stripe, reaching from the ocelli to the base of the antennæ; on the lower part there is a single row of not very stout bristles on each side, extending but a little ways on the face. Palpi black, the distal end reddish yellow. Thorax light grayish pollinose, the dorsum showing four rather narrow, black stripes, indistinct behind. Scutellum obscure yellow, or reddish yellow, narrowly black at the base. Tegulæ yellowish white. Abdomen black, the second and third segments very indistinctly reddish on the sides, the fifth segment almost wholly reddish yellow; second segment opaque; third and fourth shining, broadly whitish pollinose in front, but variable in different reflections. Legs wholly black. Wings hyaline; last section of fourth vein moderately curved inwards, posterior cross vein gently sinuous.

Male. Front narrow above, the median black stripe narrower than in the female, and gently widened in front. Palpi black at the base. The sides of the third and fourth abdominal segment broadly reddish. Otherwise as in the female.

Three specimens: one female (No. 5422), bred by Professor Forbes from *Laphygma frugiperda*, and a male and a female, collected by Mr. Eugene Keen in Fairmont Park, Philadelphia. The females

agree closely throughout; the male differs in the broad red sides of the abdomen, but I have scarcely a doubt of its identity."

No other enemies of this pest have been noted except its own fellows, but its cannibalistic habit is quite pronounced and remarkable. Glover says, in the report already cited, "The grass caterpillars, when in confinement, very often kill and devour each other; and when one is maimed in the least, it stands a very poor chance for its life. Several intelligent planters state that, when the grass and weeds are entirely devoured, and no other vegetable food is to be found, they will attack each other and feed upon the still living and writhing bodies of their former companions. One grass caterpillar, which was kept in confinement, although furnished with an abundance of green food, actually appeared to prefer to feed upon other caterpillars, no matter of what kind, so long as their bodies were not defended by long, bristling hairs, or spines."

That this is not a practice to which the worms are impelled by confinement, is shown by the fact that the older worms have been seen to destroy the younger by hundreds when a plenty of other food was available,—a fact mentioned by Mr. Howard in the Report of the Commissioner of Agriculture for 1881 and 1881.

Beyond an occasional dead worm in the fields in October, presenting the *post mortem* appearance of *schlaffsucht*, I saw no evidence of contagious disease among these larvæ, and presume that the Tachina parasite above mentioned will be found the principal enemy they have to fear.

In the past this insect has not been decidedly injurious in the same locality in the Northern States for more than one year at a time, and in the prevalence of parasitism we probably have the explanation of this fact. There is, therefore, little reason to fear a recurrence of the insect in any considerable numbers next year, in the region devastated by it this fall.

PREVENTION AND REMEDY.

The female moths, when searching for a proper place of deposit for their eggs, are evidently attracted to the ground upon which the larvæ do their damage by the presence of an abundance of green food for the latter,—a fact which immediately suggests early plowing of ground intended for winter wheat, as a preventive measure. Doubtless except for the allurement of growing vegetation, the eggs of the imago would be planted elsewhere, or so widely scattered as to effect no appreciable damage.

Certainly in that region where the grass worm prevailed last year it would be prudent to plow early after oats when it is intended to plant wheat.

If, however, this precaution has been neglected and hordes of the larvæ appear in the wheat fields, it will doubtless prove difficult to arrest their ravages. No opportunities for experiment have as yet offered, notice of the appearance of the larvæ in the wheat having been received too late to permit trial of remedial measures; but it may be worth while to suggest heavy rolling as a measure likely to be practicable and efficient in some in-

stances. This has occasionally been found useful for the destruction of the true army worm. One farmer in Mason county, who noticed that the grass worms were extending their ravages rapidly from the central area in which he first noticed them, believed that he destroyed the brood and prevented further injury by plowing under the infested area and rolling it heavily immediately thereafter. If a disposition to migration, like that of the army worm, is apparent, the march of the host may be arrested by measures which have been found more or less efficient in the case of the last named insect; that is, a furrow may be plowed across the line of their march, when the worms collecting therein may be destroyed by dragging a log along the furrow. If their appearance is easily detected while they are still small, it might not be unprofitable to destroy them with Paris green or other form of insect poison, but in most instances it will doubtless be less expensive to resow the ground than to attempt the somewhat doubtful remedies here proposed.

7. The Grain Leaf-Hoppers.

Order Hemiptera. Family Jassidæ.

A great number of species of minute leaf-hoppers are found upon growing grain, usually inflicting only insignificant or temporary damage, even if their effect is finally appreciable; but a few species were found by us last summer abundant enough in fields of growing wheat, in May and June, to constitute a menace to the crop where the conditions were not otherwise entirely favorable to its growth. Two of these, confined to the cereal crops as far as our observations show, were new to science; while a third, wide spread, occurring in many situations and upon a considerable variety of plants, is a common species, described originally by Say under the name of *Jassus irroratus*.

The first two are closely allied to *Jassus inimicus*, Say, described in 1831,* the describer of that species adding the remark that it is said to depredate, in the larva state, on the roots of wheat in Virginia.

Cicadula nigrifrons, n. s.†

(Plate V. Fig. 3.)

A moderately slender, yellowish green species, with four black points at the anterior margin of the vertex. The head is sublunate, obtusely rounded in the middle, its antero-posterior diameter next the eyes being about three-fourths its median diameter. Its color is pale yellow, irregularly mottled with white, with an arc of four irregular black points at its anterior margin, the outer of these just

* Complete writings, Vol. II, p. 382.

† Although this species differs by characters commonly esteemed generic from the following and from any other genus known to me, yet in the present state of the generic classification of our American Homoptera I have not thought it best to multiply descriptions of genera, but content myself with indicating the distinctive characters in the figures accompanying.

ARTICLE III.—BRIEF NOTES ON SORGHUM INSECTS.

My last report contained a paper on such insects as infest the sorghum plant as were then known to me, and to these I now add a few notes on one of the species therein treated, together with a description of a second species occurring upon the roots, first observed this year.

1. The Yellow Sorghum Plant Louse.

(*Chaitophorus flavus*, Forbes.)

Order Hemiptera. Family Aphididæ.

(Plate VI. Figs. 1-4.)

This species, discovered last year, was first observed July 25, and the facts of its earlier life history were of course unknown, but our observations of the present season carry the record a month farther back.

On the 2.th of June, in fields of sorghum at Champaign which had been replanted, when the plant was only three or four inches high and showed but three or four of the leaves, one of these was occasionally reddened with a small cluster of the above plant lice beneath it. Each of these consisted of a single full-grown female (winged in all cases but one) surrounded by a group of wingless young, sometimes evidently but just born. One of these winged females was dead in the center of a group of still living young. These fields were among those worst infested by this louse last year.

I searched carefully and extensively for root lice, but in vain. Every stalk seen which showed any signs of ill condition was dug up and examined, but no root lice of any sort were found. It seems probable, consequently, that the Chaitophorus emerged from the ground in spring, crawled up to the lower leaves of the young plant, and there commenced at once to multiply; and it seems unlikely that any root form of this species will be found. This year, as last, I noticed that the ants paid no attention to this plant louse, although *Lasius flavus* and other species were not uncommon in the fields at the time.

2. The Sorghum Bark Louse.

(*Coccus sorghiellus*, n. s.)

Order Hemiptera. Family Coccidæ.

Among our collections from the sorghum plant made at Champaign this year, was a single vial of specimens bearing a close resemblance to the species of Rhizobius, but evidently belonging to the Coccidæ, a family not hitherto found upon the sorghum plant.

The body is oval, distinctly segmented, .07 of an inch long by .027 of an inch wide, and .024 of an inch deep. The surface was covered by a bluish bloom, and in one alcoholic specimen examined, a waxy mass, including a cluster of long hairs, adhered to the anal extremity. The antennæ are short, reaching to the coxæ of the first pair of legs, distinctly eight-jointed, the first two joints thick and about equal in length, the third as long as the second, but more narrowed, the fourth the shortest of all, about as wide as long. Each of the three following joints is slightly larger and longer than the preceding, and the eighth is as wide as the second, cylindrical, very nearly as long as the sixth and seventh together.

The rostrum is very short, conical, projecting from between the bases of the first pair of legs, not as long as the femur, and its width about half its length. The maxillary filaments are four in number and attain the abdomen.

The eyes, placed upon the sides of the head at a distance behind the bases of the antennæ about equal to the first joint of the latter, are black and simple, each consisting of a single ocellus. The tarsi are all one-jointed, two-thirds as long as the tibiæ and tapering regularly to the single claw, which is strongly curved, with a pair of slender capitate hairs, longer than the claw, springing from its base. Tibiæ and femora of about equal length; antennæ and legs slightly hairy, and scattered hairs occur upon the surface of the body and tip of the abdomen.

The only form seen was the wingless female, and belonged apparently to the genus Coccus, as defined by Signoret.* It was collected August 4.

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* Annales de la Société Entomologique de France, trimestre de 1869, p. 102.

ARTICLE IV.—ON SOME CLOVER INSECTS.

1. Cymatophora crepuscularia, Tr.

Order LEPIDOPTERA. Family PHALÆNIDÆ.

(Plate VI. Fig. 5.)

Larvæ from which the above was bred were taken on white clover at Normal, June 21, the imagos emerging July 10. The larvæ were an inch long, slender, with only four prolegs. The head is widely bilobed and reddish brown above, yellowish varied with reddish brown in front, with two small approximate black spots on the middle of the front. The body is green, thickly covered with white granulations, with some black ones intermixed, and has an obscure reddish dorsal stripe. The posterior margins of the middle segments are narrowly bordered with yellow. On the penultimate segment is a large transverse blackish spot, with two small kidney-shaped yellow spots near its middle, approaching each other posteriorly. The legs are pale brown, blackish at base; prolegs pale brown, blackish at base; prolegs black without, pale within; spiracles brown.

The same larva occurred in our collections on the rose and the common locust; taken from the former June 20, and from the latter July 4. We also collected it July 25, from the box elder (*Negundo aceroides*), the specimen pupating August 4, and emerging August 13.

2. THE CLOVER BARK LOUSE.

(*Coccus trifolii*, n. s.)

Order HEMIPTERA. Family COCCIDÆ.

(Plate VI. Fig. 6.)

On the 3d of May, at Normal, there occurred on the roots of white clover examples of a root coccid, resembling Rhizobius in general appearance, but differing from it in the antennæ, and especially in the tarsi and tarsal claw. They were protected by a small yellow ant, *Lasius flavus*, in whose nests they occurred, and were carried away by them like plant lice, when the nest was exposed.

DESCRIPTION.

The body is elliptical, broadly and equally rounded at both ends, nearly circular in transverse vertical section, distinctly segmented; surface covered with a waxy bloom, smooth except for a few small hairs at the anal extremity. Feet, eyes, and antennæ minute. The body is .11 of an inch long, a little more than half as wide, and a little less than half as deep; the abdomen decidedly shorter than the head and thorax; the antennæ .003 of an inch long, their length less than the distance between their bases, obscurely seven-jointed; the first joint as wide as long; the second a little shorter and much narrower than the first; the third and fourth a little smaller than the second and not distinctly divided; the fifth and sixth distinct, equal in length, and about equal to the first; the seventh long, cylindrical, equal to the two preceding, obtusely pointed at tip. Entire antenna minutely sparsely hairy under a high power. Eyes simple, consisting of a single ocellus and a black speck on the side of the head, directly behind the antenna, the third joint of which will about reach them.

Legs .01 of an inch in length, each reaching about one half way to its fellow of the opposite side. Tarsus one-jointed, as long as the tibia, tapering regularly, terminating in a single stout curved claw; tibia and femur of about equal length; trochanter as long as the coxa. Legs very minutely sparsely hairy throughout. Rostrum very minute, in the form of a thick tubercle projecting downwards in front of the bases of the anterior legs, scarcely longer than wide, about half the length of the femur.

3. Clover Mites.

At Normal, early in May, the general occurrence of a large and conspicuous brownish red mite was noticed upon clover and blue grass, the former of these plants, especially, sometimes suffering severely from the pest. The leaves of the clover turned yellow and their growth was arrested where the mite was abundant. The effect upon the blue grass was similar. The species, which proved to be new, is here described by my first assistant, Mr. H. Garman.

Bryobia pratensis, n. s., H. Garman.

(Plate VI. Fig. 7.)

Body oval in outline as seen from above or below; but little elongated. Outline as seen from the side also oval, increasing in depth towards the posterior extremity where it is abruptly truncated. Strongly convex above, much less so below. Entire surface rugose with more or less parallel, waved striæ. Striæ of dorsal surface of abdomen coarser and more regular than those of the ventral surface and of the cephalothorax.

With scattered, curved, finely denticulate, scale-like appendages attached to the dorsum and at the margins. These scales expand uniformly from their bases to their tips, where they are widest and have slightly rounded denticulate margins. The four conical prominences which extend forward over the mouth parts at the anterior extremity of the cephalothorax, each bears one of these scales. The

two median prominences are longest, and are united at their bases. Palpi very stout, the basal articles with a few long hairs; inner ramus of forceps thumb-like and with spinose hairs; outer ramus a strongly curved hook.

Legs with strong, plumose, spine-like hairs on their basal articles, which hairs grow less and less stout towards the distal extremity of the limbs until upon the distal articles they form long, slender setæ. Anterior legs equal to the body in length, tapering but slightly to the distal extremity. Two basal articles about equal, the proximal slightly the stronger. Third article longest, twice the length of the sixth. Fourth article nearly as long as the sixth, about half the length of the fifth. Adhesive hairs fewer and more slender than those of the other legs. Legs of the three posterior pairs much shorter than the anterior, and with less difference in the lengths of the articles composing them.

The eyes consist of two approximated ocelli on each side of the cephalothorax. Adults in life marked with red and black. The pattern has been destroyed by alcohol. The majority of those examined have large anal protuberances.

Length of body .038 inch; width of same .025 inch.

With the above, another mite, similar, but paler and smaller, was frequently taken in meadows. It is thus described by Mr. Garman:

Bryobia pallida, n. s., H. Garman.

A small, pale species agreeing with *B. pratensis* in general form. Anterior legs slightly longer than the body, with the fourth article markedly shorter than the sixth. Scale-like appendages somewhat wider and shorter proportionally. Two outer of the frontal processes wider at their tips than those of *B. pratensis*. Median pair of processes more slender than the outer and united for half their length. Color whitish. Length of body .024 inch; width of same .015 inch. Occurs with the preceding on grasses in meadows. The anal protuberance is conspicuous in most of the examples seen.

4. Miscellaneous Notes.

The larva of *Hæmatopis grataria*, Fabr., was seen at Effingham, August 21, abundant upon white clover.

Dichelia sulphureana, Clemens, was repeatedly bred from clover leaf rollers during the season.

From small green leaf rollers collected on clover May 14, imagos of *Cacœcia rosaceana*, Harris, and of *Tortrix pallorana*, Robs., (Plate VI, Figs. 8 and 9) were bred, the imagos emerging during the middle of June. The latter species was also bred from the common ragweed, (*Ambrosia trifida*), specimens collected May 16, pupating June 12, and emerging six days later. Another example collected on *Erigeron canadense*, May 17, pupated in a fold of the leaf May 30, and completed its transformations on the 7th June. From other clover leaf rollers taken May 23, examples of *Hypena scabra*, Fabr., emerged.

II.

Contributions to Horticultural Entomology.

ARTICLE I.—ON NEW AND IMPERFECTLY KNOWN STRAWBERRY INSECTS.

1. Note on the Life History of the Strawberry Slug.

(*Emphytus maculatus*, Norton.)

Order Hymenoptera. Family Tenthredinidæ.

(Plate VII. Fig. 1.)

In my article on strawberry insects published in my report for 1883, I found myself obliged to leave in doubt an important point in the life history of this insect owing to the conflict of observations as reported by previous writers on this species.

In the fullest and most authoritative article upon it, that by Mr. Riley in his Ninth Report as State Entomologist of Missouri, the statement is made that it is double brooded, the adult flies of the first brood appearing by the end of June and the beginning of July. "Under the influence of July weather," he says, "the whole process of egg depositing, etc., is rapidly repeated, and the second brood of worms descend into the earth during the fore part of August, and form their cocoons, in which they remain in the caterpillar state through the fall, winter, and early spring months, till the middle of April following, when they become pupæ and flies again as related."

On the other hand the observations of Mr. Saunders, made in London, Ontario,* those of Mr. Galusha and Miss Smith, in Central Illinois, as reported in the Transactions of the State Horticultural Society, and the statements of Prof. French, in Southern Illinois, published in the same Transactions; together with those of Miss Alice B. Walton, relating to the life history of this species in the latitude of Muscatine, Iowa;—all report the absence of a second brood, or report their failure to detect it, the dates given by Mr. Saunders being, in fact, inconsistent with it.† The point thus left in uncertainty is practically the most important in the life history of this insect, since if two broods occur (the second appearing after the fruit is gathered), the multiplication of the species may be easily and cheaply arrested by the application of

*Fourth Report of the Ontario Entomological Society, page 18.

†For these references see my report for 1883, p. 71.

hellebore or arsenical poisons to the vines in July; but if, on the other hand, the spring brood is the only one, it must be combatted, if at all, while the fruit is on the vines, when no poisonous application would be permissible. To determine this point for Central Illinois, careful observations were made throughout the season, and a large number of individuals were reared.

On the 12th May, in Normal, McLean County, newly hatched larvæ of this species, were observed upon strawberry leaves, and numerous eggs with the partially developed larvæ within them. These eggs, some of which were kept for identification until the larvæ emerged, were not placed in the petiole, as observed by Riley, but were thrust beneath the epidermis on the upper side of the leaf, a crescentic slit having first been made by the ovipositor of the female. Attempts were made to carry these newly hatched larvæ through their transformations, and a few of them survived until June 5, at which date they were about half grown. Several young Pentatomidæ, apparently Euschistus, appeared in the cage at this time, and to their predaceous habit the disappearance of the larvæ was attributed.

On the 13th of June, strawberry slugs of this brood were found upon the leaves in the field, and on the 21st about 150 specimens were collected and placed in a breeding cage. These were fully grown, and began at once to enter the earth, nearly all having disappeared by June 24. On the 19th of July, those in the earth were examined, and found much shortened up for pupation but not yet transformed. At this time strawberry fields where they had been previously abundant, averaging as many as two or three to each leaf, were swept carefully and extensively with an insect net, but not a single strawberry slug was found.

On the 1st September, the larvæ in the earth were examined but found still untransformed, most of them enclosed in small cocoons. On November 24, these conditions were practically unchanged; one of the larvæ was dead, although yet fresh, but the others examined were living and in perfect condition.

[Delay of publication permits me to add that the above saw-flies were emerging May 14, 1885, from the lot secured for breeding June 21, of the year before.]

The above experiment shows conclusively that in the latitude of Central Illinois, and during ordinary years, the strawberry slug or false worm has but a single brood, and that this is matured before the strawberry harvest is completed, a fact which so modifies the possibilities of effective attack upon the species that we are practically limited to the application of pyrethrum or other harmless insecticides for the purpose of destroying the larvæ, and to the use of the insect net for the collection of the adult flies as they appear upon the vines in May for the deposit of their eggs, and later for the capture of the larvæ. These last are detached from the leaves at a touch, and I doubt not may be collected without great trouble or expense by sweeping with an insect net. From this they could be shaken at intervals into a bucket of water covered with a film of kerosene.

2. The Lesser Strawberry Plant Louse.

(*Siphonophora minor*, Forbes.)

Order Hemiptera. Family Aphididæ.

This species, first described last year from strawberry plants at Normal, has been, observed during the last season, throughout the central and southern part of the State, from Bloomington and Champaign to Alton and Centralia. It was first noticed this year, April 17, on strawberry plants at Normal, only the wingless form occurring at that time. It was collected at Centralia, August 6, and at Alton as late as September 25, at which time it still occurred only upon the under sides of the leaves. It has not thus far done any appreciable injury as far as known.

3. The Tarnished Plant Bug.

(*Lygus lineolaris*, Beauv.)

Order Hemiptera. Family Capsidæ.

(Plate VII, Fig. 2; and Plate VIII.)

This species, treated as a strawberry insect at considerable length in my last year's report, has been carefully observed this season, to determine some unsettled points respecting its life history and its injuries to the strawberry. Our notes began April 1, when Mr. Webster was sent to Southern Illinois to collect the facts relating to the life history of this species in spring. At this time he found the adult abundant among the young and tender leaves of mullein, both in strawberry fields and elsewhere,—not down among the older, lower leaves, where they would naturally have resorted if in search of warmth and protection only. That they were feeding upon the plant was shown by the abundance of greenish fluid with which their bodies were distended. Very few specimens were found except those upon these plants.

On the 4th April a pair were taken *in copula*, and on the 7th I dissected eggs from the ovary of the female, seemingly fully developed. On the 2d, large numbers of the adults from Southern Illinois were fed with strawberry plants and mullein in a breeding cage at the Laboratory, in the hope of obtaining their eggs and determining their breeding habits. They resorted chiefly to the mullein, but soon commenced to die from some cause not determinable, both males and females perishing rapidly. On the 17th a pair of these were seen *in coitu*, and on the 18th the plants contained in the cage were thoroughly searched for eggs, but without success. On the 22d I saw and watched for some time a specimen on the under side of a half-open strawberry leaf, with its beak inserted in the midrib, evidently feeding upon the plant, and this observation was repeated next day, the plant bug now piercing the petiole of a fully-expanded leaf.

Description of Egg.—On the 26th April, careful search was again made of the strawberry plants in the cage, and a single egg was

found on the petiole of a dead leaf, so loosely placed among the hairs that it fell off on handling the plant. This egg was unmistakably that of Lygus, as was shown by comparison with those obtained from the female by dissection. It was slender, cylindrical, slightly curved, round at one end, truncate and compressed at the other, the longer diameter of this truncate end being three times that of the shorter. The angle nearest the concave side of the egg was produced so as to make this outline somewhat sinuate. The egg was smooth, shining, pale watery yellow, .92 mm. long and .25 mm. in diameter at its widest part. The greatest diameter of the truncate end was .22 mm., and the shortest .077 mm.

The adults were found coupling in the field April 23, on flowers of the common cowslip (*Caltha palustris*), upon which they were now very abundant. They were not noticeably numerous in strawberry fields until late in April, when a few were observed in Union county, seemingly attracted by the opening blossoms. At this time they were also extremely common upon blooming currant bushes at Normal.

The young of the year first appeared about the middle of April, upon strawberry plants at Anna, and were abundant there by the 3d May. At Normal the species was not found in strawberry fields until the 12th May, and these were all adults of the preceding year.

In pursuance of my recommendation, Mr. F. S. Earle, of Anna, made some field experiments upon this species with pyrethrum, applying it quite thoroughly on one or two of the worst affected areas in his strawberry plantation. The pyrethrum used was purchased in the market, and was understood to have been effective upon other species of insects. It was diluted with from one to three parts of flour and applied with a sulphur bellows, first to about half an acre of Bidwell plants, when they were a little past their fullest bloom, and the application repeated in two or three days over about half the area. In each case enough was used to dust the plant quite thoroughly. It was also dusted on nearly an acre of Duchess plants, after the bloom had mostly fallen. Mr. Earle reported that a day or two after the application, he made as careful an estimate as possible of the number of plant bugs remaining on the rows which had been dusted and on those which had not, and concluded that there were from one-half to one-third less on the dusted rows. As this result hardly seemed to justify the trouble and expense of application, nothing further was attempted.

I am not able to account for the unsatisfactory results of this experiment as compared with laboratory experiments made the preceding year at Normal and described in my last year's report, but incline to suspect the quality of the pyrethrum.

The fact that the adults are very generally attracted in great numbers to turnips, cabbage, mullein, and other succulent plants in fall and spring, makes it possible that the number of the following brood in any limited area might be considerably diminished by bordering the field with a row of some of these plants as an attraction to the adult plant bugs. Those lured in this way might then be destroyed with pyrethrum in spring.

3. *Lophoderus velutinanus*, Walk.

This species, already mentioned as occurring in corn, was likewise bred from the strawberry this year, a leaf roller collected July 20 pupating on the 25th, and emerging at a date unknown as the imago of this species.

4. Supplementary Note on the Strawberry Root Worms.

Order Coleoptera. Family Chrysomelidæ.

In my report for last year appeared an elaborate article on these insects, (pp. 150–177), containing an account of the curious correlation of the life histories of the species included under this head, by reason of which they attack their food plant successively, the three species jointly occupying the ground as larvæ throughout the year. With a view to verifying this account, all opportunities have been improved for further observation, and the data thus collected are here given, together with additional economic notes.

Paria aterrima, Oliv.

On the 9th May this species was seen near Normal *in copula*, on raspberry leaves, upon which the beetles were feeding, during May and the first part of June.

In response to an urgent letter of inquiry from Mr. Wm. Jackson, at Godfrey, respecting the complete destruction by insects of some fields of strawberries in his neighborhood, I sent an assistant thither September 25, with directions to ascertain the cause of the injury. Three fields were visited at Upper Alton and Godfrey. In two of them the greater part of the leaves had been riddled and killed, only a few in the center of each stool remaining green. The third was so far gone, from the same cause, that it had been recently plowed up by its owner.

Careful search of these fields revealed no insect capable of doing this mischief except *Paria aterrima*, and this was so abundant as to give good ground for the suspicion that it was the author of the damage,—a suspicion fully confirmed by the fact that in the recently plowed field, the young leaves occasionally put forth had been freshly gnawed in the manner characteristic of the work of this species. It is possible that the extensive damage to these plants was largely due to the earlier work of the larvæ in the roots.

Scelodonta nebulosus, Lec. and *Scelodonta pubescens*, Mels.

(Plate IX. Fig. 1-3.)

The collections of this season and the results of breeding cage experiments all serve to confirm our former account of the life history of *S. nebulosus* and yield the further interesting fact of the occurrence, beside, of another very similar species, which feeds only on the evening primrose (Œnothera), and whose life history is very different from that of the first.

The strawberry species was bred by us June 9 to 23, from larvæ collected in Southern Illinois from April 6 to 9. Two larvæ obtained April 7, seemingly only half grown, yielded small adults June 13.

The primrose species (*pubescens*) was first noticed by us in Southern Illinois, April 4, on the primrose along the borders of strawberry fields, where it was found *in copula* at that date, and also on the 16th and 18th of the same month. Specimens transferred to breeding cages at Normal were also seen copulating as late as May 13 and 20.

Confined in the breeding cage, these beetles ate freely of the leaves of the primrose, soon killing one of the plants exposed to them, but refused to touch the strawberry, those plants placed with them on the 19th April having been uninjured May 25.

No eggs were found in our breeding cages, nor did any larvæ develop in the jars of earth containing the plants on which the adults were feeding. The primrose species certainly hibernates as an adult, laying its eggs in spring, the old imagos living at least until midsummer; but the further life history is unknown. As its occurrence in strawberry fields may sometimes needlessly alarm the strawberry grower, the distinguishing characters of the species are worthy of mention.

In *nebulosus* (from the strawberry) the form is thicker, the thorax more convex dorsally and less rugose at the sides, and the elytra much more closely punctured. Counting from the sutures to the humeral tuberosity there are seven or eight more or less distinct rows of punctures in *nebulosus*, and about fifteen such rows in *pubescens*.

ARTICLE II.—ON A FEW GRAPE INSECTS.

1. *Petrophora diversilineata*, Hübn.

This insect, well known as injurious to the grape, has heretofore been considered single brooded (except possibly in extreme southern latitudes) and supposed to winter in the larval stage, but an observation made last year indicates that it is double brooded in Southern Illinois.

Larvæ collected on the grape in Union county, September 13, 1884, were found in the imago stage in the breeding cage February 7, 1885, although the date of their appearance is not known. In Dr. Packard's Monograph of the Phalænidæ of North America, the occurrence of the imago is recorded in New York and Massachusetts from July 3 to August 17, and our autumnal larvæ must consequently have been the descendants of that brood.

2. The Vine-loving Fruit Fly.

(*Drosophila ampelophila*, Loew.)

Order Diptera. Family Drosophilidæ.

(Plate IX. Figs. 1-3.)

From Mr. A. Williams, of Moline, Illinois, I received, October 10, a bunch of grapes containing great numbers of a white footless maggot by which most of the berries had been hollowed out, with the information that this insect was making havoc with most of the grapes in his vicinity. These specimens were bred and yielded great numbers of the above common pomace fly—one of the most abundant species in orchards in autumn, when the fallen fruit is rotting upon the ground. This fly likewise swarms around cider mills, the larvæ breeding in vast numbers in the pomace.

In a later note Mr. Williams remarks: "This maggot has nearly ruined the entire crop in this locality. It began on the vines about four years ago."

This species, first described in 1862 by Loew, has been several times noticed by economic entomogists,—chiefly by Lintner and Comstock, the former of whom published an article upon it in his first report as State Entomologist of New

York (1882), and the latter, an illustrated article in the Report of the Entomologist of the United States Department of Agriculture for the same year. By Lintner the species was treated chiefly on account of its injuries to preserved fruits, and was by him given the name of the pickled-fruit fly. Prof. Comstock describes and illustrates the species fully, less with reference to its own injuries than for the purpose of enabling the fruit grower to distinguish it clearly from the apple maggot—a very much more destructive insect.

The fly is of wide distribution, occurring throughout Middle and Southern Europe and Southern Africa, as well as over Eastern North America. It is, in August, September, and October, one of the most numerous of species, wherever an abundant fruit supply is accessible, as it multiplies rapidly by many successive generations. By Prof. Comstock, each of the three preliminary stages—egg, larva, and pupa—is reported to continue from three to five days, and in some cases the fly begins to deposit its eggs when not more than two days old, the entire generation thus completing its cycle within less than a fortnight.

By both Lintner and Comstock the fact of its injury to grapes is mentioned upon the authority of correspondents, the first remarking in a foot note, that examples of the fly had been received by him from the Rev. Samuel Lockwood, of Freehold, New Jersey, with the statement that the larvæ had infested his ripe grapes during the autumn of 1881. Prof. Comstock's information of this habit was obtained from a correspondent in New York, who reported the larvæ to eat out completely the inside of the grapes "which while hanging on the vines, have first been picked open by birds. The decaying juices running out on the other berries of the cluster, spread decay and thus give more foothold for the larvæ. Indeed, the larvæ bore from one grape to another, while the imagos are constantly, by eggs, putting in new colonies until the cluster is nearly or quite destroyed, nothing remaining but the empty grape skins."

By Prof. Lintner, the same species was bred from jars of pickled plums to which the adults had doubtless got access while depositing their eggs.

No natural enemies of this species are thus far known, and it is not easy to suggest feasible remedies for its injuries in the vineyards. Unquestionably the practice of enclosing the clusters in paper bags, as is customary for protecting grapes from rot and birds, would be effective against these insects also; and it will doubtless be decidedly to the interest of the vine grower to prevent the accumulation of decaying and fermenting fruit about his premises where the larvæ may breed.

The Grape Leaf Mite.

(*Phytoptus vitis, Landois.*)

Order Acarina. Family Phytoptidæ.

The occurrence in the vineyards of Europe of a microscopic leaf mite, first described by Landois under the above name, has been known for a number of years, the injury resulting being conspicuous

and serious, and amounting in fact to one of the established and recognized diseases of the vine; but in this country nothing of the sort has hitherto been reported. On the 15th May, in a vineyard near Normal, belonging to the Phœnix nursery, I observed two grape vines of the variety known as "Taylor's Bullet," the leaves of which were curiously curled and crumpled, on some of the vines scarcely a leaf remaining unaffected. A careful examination of the injured surfaces under a microscope, demonstrated the existence on the under surface of the leaves, of considerable numbers of a minute Phytoptus having the general appearance of that described from European vineyards; and a further search in this vineyard showed a large number of other vines more or less seriously affected, some rows of young Clintons being in fact so extensively diseased that hardly a leaf could be found which did not give evidence of the presence of the mite.

Upon Concords immediately adjoining, and other thick-leaved and woolly varieties, there seemed to be neither trace of the injury nor of the Phytoptus. It is possible, however, that the mites were actually present on these leaves, but that these varieties were not susceptible to injury by them. Owing to the thick felt of hairs upon the leaf surface, it would have been extremely difficult to demonstrate the mites even if they had been present in considerable numbers.

The injury presents the form of peculiar warty elevations upon the upper surface of the leaf, and corresponding depressions on the under surface, these varying in size from one-twentieth to one-tenth of an inch in diameter, although adjacent elevations are frequently fused into irregular patches of much greater size. The larger veins of the leaf did not share in this deformity, and the effect was a distortion such as might result from a shortening of these veins and the consequent folding and crumpling of the leaf. The diseased leaves were much smaller than natural, and were frequently more or less folded together lengthwise, and the edges were also sometimes considerably incurved. On the older foliage, where the injury was of longer standing, the elevations on the upper surface were more or less browned or reddened, but when fresh they were still the natural green of the plant. Many elevated spots upon these leaves were pale, sometimes almost transparent, owing to the defective formation of the chlorophyll—a complete demonstration of the interference with the function of the leaf and the consequent effect upon the vigor of the plant, produced by these parasites.

The European writers describe and figure a peculiar development of abnormal hairs (technically called an erineum) upon the concave surfaces of the diseased patches on the leaves, but in the Clintons and Taylors nothing of this sort occurred, the inner surfaces of the cecidii (as these morbid elevations are called) being entirely smooth and destitute of pubescence of every kind. It is possible that the absence of an erineum was due to the early period at which the injury was observed, but I think it more likely that it is to be accounted for either as due to the difference in species of the American and the European grapes and the consequent difference in the reaction of the leaf from the injuries inflicted, or else that the species of Phytoptus occurring here is not actually identical with

the European leaf mite—a supposition in favor of which I shall adduce some further proof. It is worthy of remark that upon even the worst infested plants at Normal the youngest or smallest leaves were usually quite uninjured.

This same mite was subsequently found by my assistant, Mr. Garman, upon wild grapes in Southern Illinois, producing upon the leaves there an identical deformity. It seems extremely improbable that the European species could have been conveyed to this country and have become so wide spread as to reach the wild vines in forests without having hitherto attracted attention in vineyards; and I am consequently inclined to believe that the vineyard mite of America has spread in the reverse direction—that it is a native species probably belonging to our wild vines, and has from them entered our vineyards.

Indeed microscopic study of the mite itself discovers some minor points in which it disagrees with the figures and descriptions of the European *Phytoptus vitis*. The body is less strictly cylindrical, and the lateral branches of the tarsal plume are less numerous. The descriptions of the European forms by Landois and Briosi are however so inconsistent with each other (the original description of Landois giving, for example, one hundred and twenty as the number of abdominal rings, and that of Briosi from sixty to sixty-six) that it is impossible to make an intelligent comparison of our form with theirs without authentic specimens. I have consequently treated our species under the old specific name.

The specimens examined by me varied in length from .45 to .64 of an inch, and in greatest diameter from .014 to .019 of an inch. The body is broadest immediately behind the legs and thence tapers regularly, as seen from above, to the posterior extremity. The rings number about sixty-five; the tarsal plume has certainly but four lateral filaments, and not five, as reported for *Phytoptus vitis* by both Briosi and Landois.

Plant diseases due to Phytopti have hitherto been controlled only by the use of sulphur, the method being described in my First Report, page 142. As such applications are already in use for fungus affections of the grape leaf, they will doubtless be found conveniently applicable for Phytopti in the vineyard.

ARTICLE III.—ON NEW INSECT ENEMIES OF THE BLACKBERRY AND RASPBERRY.

1. The Blackberry Leaf Miner.

(*Metallus rubi*, gen. et sp. nov.)

Order Hymenoptera. Family Tenthredinidæ.

(Plate IX. Fig. 7.)

On the 12th August, at Normal, Mr. Garman found mining the leaves of cultivated blackberries, small white larvæ with brown heads, which transformed early in September to small saw flies, one specimen emerging on the 9th and another on the 10th of that month. The transformations occurred in the earth, the larvæ having deserted the leaves as early as September 6.

DESCRIPTION OF GENUS.

Anterior tibiæ with a single spine, other tibiæ with two; antennæ nine-jointed, third joint longer than the fourth, but not twice as long. Head short, about as wide as the thorax; the latter subglobular; anterior wings with two marginal and three submarginal cells, the basal marginal the smaller, the first submarginal curved, longer than the second, the third largest of all; lanceolate cells petiolate.

DESCRIPTION OF SPECIES.

Imago.—Head, thorax, and abdomen shining black, clothed with short yellowish pubescence; antennæ sparingly pubescent, strongly compressed, third joint about five and a half times the length of the fourth, fourth and fifth equal, sixth, seventh, and eighth successively a little shorter, the ninth longer than the eighth; legs pale, all the femora and the posterior tibiæ fuscous; wings smoky, almost black, wing veins black, but slightly tinged with fulvous. Length, 3.5 mm. expanse, 8.5 mm.

Described from two specimens bred from blackberry leaves.

Larva.—The larva is 8.5 mm. in length by 1.25 mm. in breadth, cylindrical, skin minutely roughened. The second and third thoracic segments and the first abdominal are much thickened vertically, giving a convex dorsal outline to this region. From the second

thoracic segment the outline slopes rapidly downward to the front, the head being wedge shaped, viewed laterally, and only about half the depth of the second segment. The head is flat beneath, slightly rounded above, about two-thirds as wide as the thorax; antennæ and mouth parts very short; eyes wanting. The color is brown both above and beneath. First thoracic segment trapezoidal, viewed laterally; a large brown chitinous prosternal area extending forward to the mouth parts and laterally to the legs; a brown patch upon the dorsum of this segment. Small brown chitinous sternal areas to the two succeeding thoracic segments, and a still smaller one on the first abdominal.

Legs very short, not longer than their respective segments; prolegs fourteen in number, (counting the two anals), having the form of low, flattened tubercles, each with a brown chitinous patch upon the outer part. The pair of anal prolegs are nearly encircled by two dark brown chitinous arcs.

Segments of the body deeply separated; sides with two lateral rows of obscure tubercles; spiracles brown, minute, except the first on the middle of the first thoracic segment, which is larger and is surrounded by a small brown chitinous patch.

Described from a single specimen taken from the blackberry leaf.

2. *Lophoderus velutinanus*, Walk.

From leaf rollers of the blackberry, collected at Normal, June 30, specimens of this species were obtained July 10 to 18. The food plants heretofore recorded for it are oak, balsam fir, and maple.

3. *Pyrrhia umbra*, Hübn.

Order LEPIDOPTERA, Family NOCTUIDÆ.

(Plate X. Fig. 1.)

Late in May and early in June we found repeatedly, feeding upon leaves of blackberry at Normal, large whitish larvæ, with a lemon-yellow band upon the sides, and numerous conspicuous small black tubercles upon each segment. Numbers of specimens were bred, resulting in orange-brown moths of the above species.

LITERATURE.

This species, common to this country and to Europe, has been repeatedly noticed in American entomological publications, most of the references to it, however, being of a purely technical sort. Under the name of *Heliothis exprimens*, it is mentioned by Grote and Robinson in their descriptions of American Lepidoptera,* with some remarks on its distribution and synonomy.

In 1873, the authors catalogued it as *Chariclea exprimens*.†

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* Transactions American Entomological Society, Vol. III, p. 180.

† Transactions American Entomological Society, Vol. IV, page 432.

In the Seventh Report of the State Entomologist of Illinois, that for 1878, the occurrence of the species at Carbondale is noted by Prof. French, brief descriptions of larva and imago are given, and mention is made of its injuries to the rose.

A description of a larva of an allied species, *Pyrrhia angulata*, (according to some authors identical with this), was given by Mr. Coquillet in the first volume of Papilio (1881). In Volume X of the Transactions of the American Entomological Society (1883), Mr. J. B. Smith figures the fore wing of both these species, (considering *angulata* a variety of *umbra*), and quotes Mr. Coquillet's description of the larva of the former. By Smith the species is placed under the genus Chariclea. On page 259 of the same volume, Mr. A. R. Grote objects to this generic assignment and insists upon Pyrrhia as the proper generic name for the species, not considering Chariclea a homogeneous group, as defined by its author. He also insists upon the specific distinctness of *angulata*. In the third volume of Papilio, pages 135–36, Messrs. Edwards and Elliot give descriptions of the full-grown larva and pupa of this species under the name of *Pyrrhia exprimens*, and mention *Desmodium* as a food plant.

DESCRIPTION.

Larva.—The full-grown larva is 1.36 inches in length, pale bluish white above and greenish beneath, with a bright lemon-yellow stripe along the side, including the stigmata, and above this a pale bluish stripe of about the same width heavily bordered with black above and beneath. The dorsal and sub-dorsal regions are pinkish bluish white, marked with irregular specks and lines having a tendency to arrange themselves in five black stripes most conspicuous on the second and third thoracic segments.

The head is pale chestnut, inclined to orange; cervical shield nearly covered by eight large square black blotches in two rows of four each, the middle blotches of the posterior row being much the largest of all; abdominal segments each with four large conspicuous piliferous black tubercles upon the dorsum, one in front of the spiracle, one just below the edge of the yellow stripe, and another above the base of the proleg. The jointed legs are all black, prolegs shining black without and dusky at the tip. The anal segment is widely bordered with black posteriorly, and a broad black patch extends forward from the middle of this arc. On the two segments preceding this, the dorsal piliferous tubucles are much more conspicuous than elsewhere. Spiracles black.

Pupa.—The pupa is three-fourths of an inch in length, shining, dark brown, the spiracles slightly darker, surface smooth except for some large punctures on the abdominal segments; abdomen terminating in two slender, slightly hooked spines.

Imago.—The front wings and thorax of the imago are brownish orange, varied with yellowish, hind wings pale yellow at base, brownish red on posterior half. Examined with a glass the brown color of the front wings is seen to be irrorate with reddish scales. Transverse anterior line red, zigzag with three angulations; orbicular well marked, of the ground color of the wing ringed with red. Middle

transverse line distinct, obtusely angulated opposite the reniform spot, the posterior boundary of which it reaches, thus running obliquely to the posterior margin. At the angle of this line is an obscure reddish shade which invades the reniform spot.

Posterior transverse line broader than the others, oblique, nearly black. Between this and the subterminal line is a purple shade, heaviest inward. The latter line is irregularly scalloped, being dentate on the veins. A slender terminal line; fringes purple whitish at base, costa with two oblique white marks in the vicinity of the transverse line or between that and the subterminal.

Fringe of posterior wings white, slightly tinged with purplish; under surface of both wings pale yellow, with purple shades corresponding to those of the upper surface, and a purple spot representing the reniform.

DISTRIBUTION AND LIFE HISTORY.

This species has been reported from Canada to Pennsylvania and Illinois, occurring in the last throughout the whole State. Specimens found upon blackberries, May 28, pupated about June 15 and commenced to emerge on the 5th July, the last of this lot appearing August 21. Another specimen entered the earth July 10, and emerged on the 18th August. With Prof. French of Carbondale, larvæ obtained early in June had all entered the earth on the 19th, and emerged from August 5 to 31. On the other hand, larvæ of *Pyrrhia angulata* (not impossibly identical with this) obtained by Coquillet from smartweed (*Polygonum pennsylvanicum*) September 15, entered the earth on the 27th and disclosed the imagos on the 22d May of the following year, and a few days thereafter. It is consequently possible that this species is two brooded.

INJURIES TO VEGETATION.

The injuries to vegetation noted thus far, are confined to the worthless plants Desmodium and Polygonum, and to the rose and the blackberry. By Prof. French, in Jackson county, the young larvæ, when about half an inch in length, were noticed eating and disfiguring roses, feeding within the flower rather than on the outside, and seeming to prefer the bases of the petals.

At Normal, as already mentioned, the larvæ were found only upon the blackberry, devouring the leaves. The damage was occasionally decidedly serious, in some cases nearly every cane bearing one or more of the larvæ. These were feeding upon the tender leaves near the ends of the stalks, in company with *Oxyptilus delavaricus*.

4. The Raspberry Plume Moth.

(*Oxyptilus delavaricus*, Zeller.)

Order Lepidoptera. Family Pterophoridæ.

(Plate X. Fig. 2.)

Late in May we found occasionally at Normal, feeding upon the leaves of the blackberry, a very peculiar, small green larva, having a general resemblance to the raspberry slug, (*Selandria rubi*), but belonging to the Lepidoptera. This larva, new to us when first observed, was determined by breeding to be that of the plume moth, *Oxyptilus delavaricus*, of the family Pterophoridæ.

This insect has already been noticed in Saunders' Insects Injurious to Fruits (pp. 314 and 315), where figures of the larva and imago are given, and all these stages are briefly described, but the species is not there identified. For the determination of the specimens bred by me I am indebted to Prof. Fernald, of Orono, Maine.

The larva, when full grown, is about .4 of an inch long, of a pale green color, sometimes slightly streaked with pale yellow; with a single transverse row of six large tubercles to each segment, each tubercle bearing a spreading cluster of stiff spines which are slightly emarginate at their tips. The dorsal rows of tubercles are larger than those upon the sides, and the spines upon the former (six or eight in number) are likewise the longest of all. Scattered spines also occur elsewhere on the body.

The prolegs of this larva are of very unusual form. They arise from thick wart-like bases, and extend downward a distance equal to two-thirds the depth of the body, as smooth, straight, slender, tapering appendages, which expand suddenly at their tips. The posterior pair of these prolegs, however, thicker than the others, are beset with spines.

The tarsal joints of the articulated legs are similarly slender, tapering, and elongate, and each terminates with a movable claw capable of shutting back against the tip of the extremity.

The head is yellowish, smooth, with a few long bristles in front, mouth parts dusky, thoracic legs nearly black, the abdominal prolegs pale at base, but rapidly darkening and becoming black on the distal half.

The pupa is green when fresh, angular, margined on each side with a whitish ridge, and with a double row of clusters of stout branched spines along the back. The abdomen is slender and acute; the wing pads extend three-fourths the length of the body, the head and thorax being decurved so as to give the front of the pupa an obliquely truncate outline. The back of the thorax is beset with rather slender simple spines; wing pads and under surface of the body smooth except for a thick transverse tuft of hairs upon the middle of the under side of the abdomen, a short distance behind the tip of the wing pads.

Length 8 mm.

General color of the imago, chocolate brown; antennæ black, specked with white internally; thorax brown, with a white collar and a curious metallic purple reflection. The abdomen is brown, white at the base, and variously white-specked above, almost wholly white beneath.

The fore wings are of the general color, minutely specked with bluish white, especially along the costa, and crossed by two transverse white bands beyond the origin of the fissure, the inner of which is the wider, although both are frequently reduced to narrow lines, or occasionally obsolete. The fringe of each lobe of this wing is black, with a large cream-colored patch at the apex, except that that of the posterior lobe is white on the proximal half. The slender posterior lobe of the hind wing is brown at the base, white in the middle, and black on the terminal third, except for a cream-colored patch upon the fringe of the apex. The markings beneath repeat substantially those of the upper surface.

Specimens obtained May 28, pupated on the leaves from June 2 to 11. They commenced to emerge on the 13th, and had completed their transformations by the 18th of that month.

ARTICLE IV. ON THE SPECKLED CUTWORM AS A CABBAGE WORM.

(*Agrotis c-nigrum L.*)

Order LEPIDOPTERA. Family NOCTUIDÆ.

(Plate X. Fig. 3.)

Several times during the last three years, my attention has been called to a large brownish gray caterpillar, marked with oblique black dashes upon the posterior part of the back, found in June and July boring the heads of early cabbage. The character of the injury inflicted was much more serious than that done by the common cabbage worm, (*Pieris rapæ*), not only because of the larger size of the caterpillars but especially because of their habit of immediately penetrating the head and mining in all directions, a single larva thus destroying the head more completely and in less time than would scores of the ordinary cabbage worm. This caterpillar was by us determined as the larva of *Agrotis c-nigrum*, a common noctuid moth, a determination verified later, several times, by breeding.

This is one of the common cutworms, feeding habitually upon grass and upon a great variety of vegetables, but whose injuries to cabbages have been hitherto unnoticed by economic entomologists, as far as I am aware, except those done to the young plants by a brood of the larvæ preceding that which attacks the full-grown cabbage. Our observations on the injury noted have been confined to the vicinity of Normal, with the exception of a single report from Dr. E. R. Boardman, of Stark county, accompanied by specimens of the cutworms which he found eating holes in the heads of his cabbages and causing them to rot. He reported them in July of the present year as quite common on his heads of cabbage and on those of his neighbors.

DESCRIPTION.

The typical full-grown larva has the following characters:

It is 1.2 inches in length by 0.2 inch in width at the widest part of the body, and is much narrowed anteriorly, the first segment being less than half the width of those at the middle of the body. Posteriorly, the diameter hardly lessens, so that the body is obliquely truncate behind.

The general color varies from greenish to fawn, freshly moulted specimens being bright green. In a mature specimen the fawn color is plainly mottled with black and white. There is a delicate obscure dorsal line of white, more or less evidently bordered by a darker shade, deepest upon the incisions, producing an appearance of obscure black points. From these points oblique lines pass forward and outward across the dorsal space to the subdorsal line, these lines being paler than the ground color and bordered anteriorly with black. These black dashes become more conspicuous on the posterior segments than the accompanying pale lines, and are there converted into oblique triangular blotches. In some examples these blotches are evident the whole length of the body.

The subdorsal space is more densely varied with black than the dorsal, giving the sides a darker tint, but the ground color is the same. The lower part of the subdorsal space is more distinctly gray than the upper. A narrowish white stigmatal line margins the sub-stigmatic space above; this latter being a reddish drab, variegated with whitish.

The venter and prolegs are slightly paler and reddish. The head is reddish brown, with two pale brown longitudinal lines. The stigmata are white, ringed with black. The cervical shield is inconspicuous and colored like the body. The piliferous tubercles are small, and the hairs short. In some specimens the lower border of the subdorsal space is marked by a row of longitudinal black dashes. The subdorsal space itself is decidedly darker, and the sub-stigmatic space is a yellowish tint.

The pupa is seven-eighths inch long by two-eighths inch in greatest diameter, reddish brown, fore part opaque, segments of abdomen roughened at articulations, otherwise smooth and shining. Abdomen terminating in two slender spines, with two minute spinules at their bases, one on each side.

LIFE HISTORY.

Our data indicate at least two broods of the species, and there is possibly a later one also. The larvæ have appeared in our collections from April 24 to May 6, and again in the middle of July. Those taken in April pupated from the 26th of that month to the 6th May, the imagos emerging from the 10th May to the 21st, a single belated specimen appearing on the 11th June. Specimens pupating on the 26th emerged five days later. Larvæ taken from cabbage on the 16th July entered the ground on the 25th, and emerged from the 15th to the 19th August. As the larvæ obtained in April were adult, the species evidently hibernates in the larval stage. From the specimens in our breeding cages emerged two hymenopterous parasites of the sub-family Cryptides, but which I have not further determined.

ARTICLE V. NOTES ON INSECTS INJURIOUS TO THE APPLE AND PEAR.

1. *Datana contracta*, Walker.

Order LEPIDOPTERA. Family BOMBYCIDÆ.

From a number of yellow-necked apple caterpillars collected on apple trees August 13, 1883, and used in an experiment upon a contagious disease of insects, two pupæ resulted, one of which emerged. This, to my surprise, proved to be an unquestioned *Datana contracta*, agreeing in every essential particular with the description and figures given by Grote and Robinson in Volume VI of the Proceedings of the Entomological Society of Philadelphia.*

The discal spot upon the first brown line of the anterior wing is not evident, however; the first and second lines meet on the inner margin of the wing; and the fourth line is nearly obsolete. In other respects the correspondence is exact. The larva pupated September 14, 1883, and the moth emerged June 23, 1884.

2. *Biston ypsilon*, n. s.

Order LEPIDOPTERA. Family PHALÆNIDÆ.

(Plate X. Fig. 4.)

A single looping larva, two inches long, was obtained from the apple near Warsaw, June 26, 1883, and fed upon apple leaves until July 7, when it entered the earth for pupation. Here it remained until April of the following year, on the 8th of which month the living moth was noted in the breeding cage.

Imago.—The single male specimen bred is of a brownish gray color; head dusky gray; palpi black; antennæ dusky, widely pectinate; thorax gray, with three transverse dark lines, the anterior and middle arcuate, the posterior straight. The front wings are brownish gray specked with black on basal and terminal thirds, marked with three transverse black lines with the space between the first and third pale gray minutely specked with black, these specks taking the form of transverse lineations on the costa. The inner line is obliquely arcuate, its inner end being about half the distance of the outer from the base of the wing. The third line is sinuate, bending broadly forward around the end of the discal cell and then running nearly

* Page 14, and Plate II, Figures 5 and 6.

directly to the internal margin. The middle line is straight, and joins the inner end of the third before it reaches the internal margin. About one-half the distance from the third transverse line to the posterior margin is a jagged, pale, transverse line extending across the wing. The posterior wings are pale gray, marked with two transverse lines, the inner of which is straight and the outer sinuous like that of the fore wing. Beyond this is an obscure subterminal whitish band. Upon the middle of the wing, between these lines, is a distinct black spct. The wing beyond the outer transverse line is more irrorate with dusky, the fringe pale with blackened scales in the intervals between the veins. The first segment of the abdomen is covered with long gray pile; the remaining segments are fulvous brown, with a double row of black blotches along the middle.

Larva.—Length, when full grown, two inches. The general color is a reddish drab, ornamented with numerous irregular longitudinal stripes of a reddish hue, varied with yellow and bordered with jagged lines of black. Four of these bands are continuous upon the back, but vary greatly in width. On the sides they are much interrupted, the stripe below the spiracles being broken up into irregular patches. That immediately above the spiracles is regularly interrupted, disappearing at the middle of each segment. On the last two segments all the bands are much interrupted and very irregular. The dorsal stripes are confluent a little behind the middle of each segment, from the fourth to the eighth, with the exception of a central stripe of the ground color, by which all the transverse bands are broken. These confluent band-like areas of the longitudinal stripes are, at first, yellow, but all change to russet with the last moult, except the anterior one, which remains a bright lemon-yellow. The surface is smooth with the exception of a transverse row of about five black hairs to each segment, each arising from a minute tubercle. There is also a prominent tubercle behind each spiracle (excepting that upon the first segment), bearing a black hair at its apex. This row of lateral tubercles is variegated with rose and yellow, and each is surmounted by a jagged black line, which includes the black spiracle in the area described by it. The ventral surface has the same ground color as the dorsal, and is similarly marked with longitudinal stripes, which are, however, less distinct than the above. The head is irregularly punctate, patches of the punctures being black, giving the surface a mottled appearance. The general color of the head and first segment is lighter than that of the other parts of the body. The anterior segment has a yellow front margin, interrupted in the middle by the median stripe already described. The legs are ringed with black and yellow at the articulations, and are elsewhere more or less spotted with black. Upon the antepenultimate segment are two prominent black tubercles, one upon either side of the median stripe, each bearing a stiff bristle at its apex; and similar bristles are scattered over the dorsal surface of the succeeding segments. The last segment with the corresponding prolegs is punctate with black, and bears two smaller setose tubercles similar to those above mentioned. The preceding pair of prolegs are irregularly striped

and mottled with black, rose, and yellow, like the sides. Some transverse rows of minute black hairs are visible upon the under surface, two or three to each segment.

3. The Apple Leaf Roller.

(*Cacœcia rosaceana*, Harris.)

Order Lepidoptera. Family Tortricidæ.

The larva of this insect, well known to be injurious to the apple from its habit of rolling and eating the younger leaves, was observed early last May engaged in a much more mischievous attack, eating the stamens and pistils out of the freshly opened flowers. As the flowers disappeared, these larvæ resorted to the young leaves, according to the usual habit of the species. Specimens collected on the 10th of May, pupated June 9, and emerged as imagos June 16.

4. The Apple Leaf Skeletonizer.

(*Pempelia hammondi*, Riley.

The Lesser Apple Leaf Roller.

(*Teras malivorana*, LeBaron.)

Order Lepidoptera. Family Tortricidæ.

(Plate X. Fig. 5.)

In nurseries near Normal my attention was called this year, as last, to the extraordinary abundance of the above insects, the effect of whose presence began to declare itself most evidently late in June. Much of the young nursery stock was so seriously affected during this active growing season that its growth was completely arrested; and as these larvæ remained active this year until the leaves fell in autumn, a large percentage of the young trees made no good growth whatever. The varieties with thick and woolly leaves, were, however, little attacked, the moths having evidently selected the smooth and thinner-leaved varieties when depositing their eggs. We made various experimental attempts upon these insects in the field, using a force pump for the distribution of a kerosene emulsion and of pyrethrum suspended in water. We also applied powdered lime with a bellows, but none of these applications had a sufficiently pronounced effect to make their continuance advisable. A small percentage of the worms would die when thoroughly drenched with the fluids, but rolled as they were in the leaves and protected by their webs, it was impossible to reach them with any thoroughness. On one occasion three days after a complete drenching of the trees with the kerosene emulsion, ten still living larvæ were taken from a single small tree about three feet high.

Against these insects, methods of protection must evidently be the main reliance. If the nurseryman waits until their injuries alarm him, the time for checking their ravages is substantially past. Both these species pupate in the leaves, either upon the tree or upon the ground, and may be destroyed by collecting and burning the rubbish between the rows; or watching for their first appearance early in the season, the foliage may be sprayed with arsenical solutions, or with Paris green or London purple in suspension, thus poisoning the young larvæ as they hatch or the older ones as they extend their webs.

5. *Crepidodera helxines*, L.

Order LEPIDOPTERA. Family CHRYSOMELIDÆ.

The little flea beetle was noticed June 22, riddling the leaves of apple trees near Normal; and the common cucumber flea beetle. *Crepidodera cucumeris*, was also detected at the same work as early as the 10th of May.

6. THE APPLE PLANT LOUSE.

(*Aphis mali*, Fab.)

Order HEMIPTERA. Family APHIDIDÆ.

In his article on this species in the Eighth Report from this office, Dr. Thomas expresses a doubt whether the common apple leaf aphis of Illinois, is the above species or that described by Fitch from Mercer county, Illinois, under the name of *Aphis malifoliæ*.* Careful examination of the winged form of all the apple aphides in the collections which we have made during the last two years in Southern and Central Illinois, shows not a single specimen of *malifoliæ*, all being distinctly *mali*.

It is worthy of remark that the second fork of the third vein of the anterior wing is often very small, and sometimes even disappears entirely, so that this vein presents but a single fork,—a character which, taken by itself, would exclude such specimens from the genus Aphis. When present, the fork varies from one-half to one-sixth or one-seventh of the length of the first.

7. THE YELLOW JUMPING PEAR LOUSE.

(*Trioza pyrifoliæ*, n. s.)

Order HEMIPTERA. Family PSYLLIDÆ.

(Plate X. Fig. 6.)

The injuries to the pear done by the common jumping pear louse (*Psylla pyri*) are well known to economic entomologists, and have

been characterized in a brief article upon this insect published by Dr. Thomas in our Eighth Entomological Report. I have here to record the occurrence in Illinois of a second species of this family, similar in habit, (and apparently in life history also), to its well-known relative.

This is a small yellowish species which we found at Normal on the 7th of May, and occasionally thereafter, puncturing the blades and the petioles of the leaves of the pear trees. It presents all the characters of the genus Trioza, having, however, the frontal lobes greatly inclined (projecting downward decidedly more than forward) so as to present the aspect of a beak.

It averages .1 inch in length. The surface is opaque, thorax brownish yellow, abdomen blackish brown. The head is twice as wide as long across the eyes, nearly as wide as the thorax; the vertex very widely emarginate in front, the foveæ opaque but not rugose, very large, occupying nearly the whole of the upper surface. The vertex is usually black, edged with yellow posteriorly, but the black is sometimes reduced to a transverse blotch surrounded by yellow, or even to two black spots occupying the centers of the foveæ. The face is black, frontal lobes diverging somewhat, hairy, with the longer hairs varying in color from white with black tips to wholly black. The antennæ are as long as the head and thorax, the two basal joints and the basal half of the third white sometimes shaded with dusky. The third joint is four-fifths as long as the fourth and fifth together. The last two joints are thickened, closely united, forming a slight club, and the last bears a minute cylindrical appendage at its inferior tip and a short hair above.

Pronotum narrow, white in the middle, brown or black on the sides, with a white point upon the lower edge. The dorsulum opaque, naked, a little longer than the mesonotum, closely and minutely punctured, brownish yellow, often clouded with dusky, most distinctly seen in front, where brownish blotches sometimes appear, one upon either side of the middle. The sutures are all black, posterior margins straight in the middle; the sides, a little distance in front of the suture, bearing each a short black spine.

The mesonotum and scutellum are brownish yellow, alutaceous like the dorsulum, with a conspicuous lanceolate or oval longitudinal brown stripe or blotch on each side the middle, and an oblique blotch outside this, usually less evident than the preceding. Scutellum vaulted, plain in all the specimens examined. Wings hyaline, nerves brownish yellow.

The legs of the first and second pairs are sometimes wholly dusky, except the tarsi, which are black, but the femora are sometimes dusky only above, and the tibiæ only in front. The hind femora are commonly dusky above, but the tibiæ and the basal joint of the tarsus pale. Abdomén purplish brown with pale posterior edges to the segments; conspicuously hairy at tip.

Described from ten specimens.

Another species of Trioza, (*T. diospyri*), first described by Ashmead from the persimmon in Florida, and found by us abundant on that tree in Southern Illinois, was likewise occasionally seen at

Normal on the pear. As the persimmon is unknown in this vicinity, the species doubtless occurs on other trees. We have not found it, however, upon cultivated fruits in numbers to indicate any probability of injury to them.

This species is larger than that just described, shining black, more or less pubescent, especially upon the head and thorax. The frontal lobes are short, very obtuse and project forward from the vertex.

It is probable that *Trioza pyrifoliæ*, like *Psylla pyri*, winters as an adult and lays its eggs upon the young leaves in spring. The young of the common species fix themselves habitually upon the young twigs or wood of the previous year, and, piercing the still soft bark with their long beaks, remain stationary except when disturbed. The fluid excrement of the louse attracts ants and other syrup-loving insects, as does that of the Aphis. As the larvæ obtain their growth, they spread to the under sides of the leaves. Where these insects are abundant, the continual drain upon the sap of the young twigs arrests their growth, and the tips of the leaves and twigs may die.

The various insecticides found available for plant lice take effect likewise upon these jumping leaf lice, the most promising topical application doubtless being the kerosene emulsion with soap.

8. The Willow Saw Flies.

(*Dolerus arvensis*, Say; *Dolerus bicolor*, Beauv.)

Order Hymenoptera. Family Tenthredinidæ.

(Plate X. Fig. 7.)

From one of the most intelligent and observant fruit growers of my acquaintance, I have heard from time to time of a "steel-blue fly" which clustered in spring upon the buds and blossoms of the pear, either eating them or blighting them and causing them to drop. On the 30th March he sent me specimens from his pear trees, and I found them to be the adults of the above two species which are known as willow saw flies,—so-called because their green, many-footed larvæ feed on the leaves of willows. The evidence against these saw flies lay in the fact that they were abundant and busy upon the opening buds and fresh blossoms of the pear and of some other trees, for many days in succession, and that the blossoms afterwards fell without setting fruit. Afterwards a similar but more positive charge against these insects appeared in the correspondence of the "Western Rural" of Chicago, for May 17, 1884, as follows:

"Enclosed you will find a couple of bugs that are working on fruit trees here. They ruin many blossom buds by sucking the sap out of them, sometimes causing them to fall off just before opening. They make their appearance as soon as the trees begin to grow.

You will notice there are two colors of bugs—red and black. Is there any way to get rid of them? Poison won't do it, for I have tried London purple. They suck the sap mostly, although I think later in the season they eat the leaves some, but am not sure of it. They work on pear worse than others."

The first of these species, *Dolerus arvensis*, was originally described by Thomas Say in 1824, and the second, less common but still abundant, by Beauvois, in 1805. Although the larvæ of the former, at least, have been known for a long time to feed upon the leaves of willow, they have not otherwise, so far as I am aware, been suspected of any injury to vegetation of economic importance, all the references to them in the literature of entomology being of a strictly technical character. From other insects occurring in similar situations, with which they are at all likely to be confounded, they may be distinguished by the following characters in addition to those of the family Tenthredinidæ, to which these insects belong:

The first, *Dolerus arvensis*, is a little more than one-third of an inch in length by about one-third as wide, and measures not far from two-thirds of an inch across the extended wings. The head and body are dark steel blue except the thorax, which is variegated with yellow and black.

The other species, *Dolerus bicolor*, is a trifle smaller than the first, brownish yellow except the wings, the head, the middle of the thorax, and the legs, all of which are black.

Both these insects are abundant everywhere in early spring, and the larvæ of both, similar in appearance to green caterpillars, but distinguished by the possession of eleven pairs of legs, feed upon the leaves of the willow a little later in the season.

Careful watching in the field soon convinced me that these saw flies were neither biting nor piercing the buds or flowers, but that they were merely licking off the semi-fluid exudation from the surface of the bud scales. Dissecting the specimens and examining the contents of their stomachs with the microscope, I found only a clear fluid, without a trace of solid matter except occasional spheres consisting of clusters of threads of fungous parasites. Critically searching the surface of a bud scale which these flies had but just worked over, I saw that no injury whatever had been done to the tissues of the plant, even the slender hairs with which the scales were covered being wholly undisturbed. Watching the flies with a glass, I could see that their biting jaws remained all the time closed, but that their flap-like maxillæ were continually employed in mopping up the moisture from the viscid surface, and as they have no mouth parts capable of piercing the substance of a plant, it was clear that no injury was being done. Finally, I confined a lot of the saw flies in a breeding cage with pear buds not yet open. The insects industriously worked over the surfaces of the unopened buds and even entered the flowers as they expanded, but did neither any visible injury whatever. The buds afterwards all opened out in abundant bloom, and remained fresh for several days, while the poor saw flies, having lapped up all the syrup available, starved to death in the midst of the uninjured blossoms. A little experiment

showed that they were especially susceptible to the influence of pyrethrum, and that a single thorough application to a tree would kill all upon it at the time.

The above brief account of these insects is given merely to set at rest the fears of those who, like my correspondents, may be led to attribute to them serious mischief really due to quite other causes.

ARTICLE VI.—ON SOME INSECT ENEMIES OF THE SOFT MAPLE (*ACER DASYCARPUM*).

1. Notes and Experiments on the Soft Maple Bark Louse.

(*Pulvinaria innumerabilis, Rathvon.*)

Order Hemiptera. Family Coccidæ.

(Plate XI. Figs. 1 and 2.)

This annoying and even destructive species, which attracted so general attention four years ago and then suddenly disappeared from view, commenced, last year, to appear again in noticeable numbers on the soft maples throughout Central Illinois, and during the season just passed was excessively abundant throughout the State from at least as far south as Shelbyville to our northern limits. Notwithstanding the length at which it has been treated in former reports from this office, and the numerous articles upon it which have appeared in the agricultural and political papers during the last few years, great numbers of my correspondents were unacquainted with the name and life history of the species. In fact, fully half the entomological correspondence of this office during the months of June and July related to this bark louse. In the earlier articles upon it in the Report, some premature conclusions were reached with respect to its life history, and I do not know that exact experiment has heretofore been made with respect to its destruction.

The females of the preceding year which had wintered upon the twigs of the maples, began to attract general attention early in June, they having by this time attained their full growth and developed the cottony egg masses beneath the scales into which their bodies had become practically converted. By the middle of June it was easy to see that the lice were abundant almost everywhere upon the maple, and they commenced to appear likewise upon a number of other trees and plants. On the 14th, we noticed them upon the pear and box elder at Normal, and on the 16th, upon the grape and walnut at Quincy, and upon the pawpaw, grape, and honey locust, at Normal.

As the young hatched, they spread in great numbers over the vegetation in the vicinity of the trees where they had their origin, and attached themselves to a great variety of plants, both shrubby and herbaceous, besides those mentioned above. We found them upon the bass-wood, green ash, American elm, black locust, osage orange, plum, and cherry, and in their second stage upon leaves of clover and smartweed, upon wild cucumber, and upon the gooseberry. In fact, their young occurred, in the middle of July, upon nearly all the herbaceous plants within one or two hundred feet of infected trees; clover, plantain, Polygonum, mustard, various grasses, and *Bidens frondosa*, being the species apparently preferred. The latter plant seemed to suffer considerably from their attacks, the leaves being paled, spotted with yellow, and slightly curled when worst infested. By the latter part of July the larvæ in the second stage were common upon the under sides of the leaves of strawberries near infested trees, causing them to contract and curl.

The ultimate fate of these individuals which fixed themselves upon herbaceous plants and throve there, for a time at least, we neglected to make out, but it is probable that the greater part of them perished in autumn, although some may have succeeded in migrating at this period (when the young upon the trees are passing from the leaves to the twigs) to woody plants on which they could maintain themselves until the following season. The fact that in nurseries we sometimes found the young very abundant upon the suckers at the bases of the trunks of trees which were themselves but little infested, tended to confirm this supposition.

I noticed a marked difference in the stage of advancement of the brood upon different trees, some retaining still a considerable percentage of the eggs unhatched in the cottony masses attached to the twigs, after others had practically yielded all their young, and the obsolete bodies of the females and the egg masses had fallen to the ground, or were hanging in ragged shreds from the branches of the trees. As late as July 13, on some trees in Bloomington, fully twenty-five per cent. of the eggs were still unhatched. By the 20th of the month the young had nearly all left the nests of the mother bark lice and were established on the leaves, although a few eggs could occasionally be found which were still unhatched.

By the 16th August the injury effected by this new brood was at its height, and many trees in the vicinity of Bloomington lost a considerable part of their leaves, and the others were blackened and dwarfed, giving the branches a bare and unthrifty look.

By the 30th October all the living bark lice had deserted the leaves, except a few found occasionally upon the petioles, but thousands of them occurred upon the under sides of the twigs and branches of nearly every tree of the species worst infested, (*Acer dasycarpum*), the twigs being often crowded to their very tips.

The common insect enemies of the species were moderately abundant throughout the season, the small black Coccinellid beetle, *Hyperaspis signata*, whose larva is found embedded within the egg mass devouring the eggs, being the most destructive.

The minute hymenopterous parasite described by Miss Emily A. Smith under the name of *Coccophagus lecanii** was not infrequent. Numerous specimens emerged in our breeding cages early in October, at which time also the adult Hyperaspis appeared abundantly. Only an insignificant percentage of the brood was actually parasitized, however, and the number of these parasites occurring was far below those of the year 1880, at which time the last previous uprising of this species culminated. There is consequently every probability that the maple bark louse will be certainly not less abundant next year than this, but probably far more so, and that the year following will be marked by their almost total disappearance.

An interesting observation of my first assistant, Mr. H. Garman, is here inserted from his notes dated July 24.

"A nest of the goldfinch, *Chrysomitris tristis*, was found to-day in an osage orange hedge, and on examination proved to be covered outside with the silken nests and bodies of the female of *Pulvinaria innumerabilis*. These had been collected some distance away, as there were no maple trees in the neighborhood. There were no bark lice on the leaves of the hedge at a distance from the nest, but in the neighborhood of the latter the leaves were covered with them, some still active. The fact illustrates a means of dispersal for this bark louse which does not seem to have been noted by writers."

Experiments.

For the purpose of testing precisely the value of various local applications to trees infested by the maple bark louse, I instituted a series of experiments with all the substances likely to be of economic use, and the results are herewith given.

Kerosene Emulsion.

On the 18th July, when the leaves of the trees were generally infested by the young, we began experiments with the kerosene emulsion, using a strong soap suds for the preparation of the emulsion, and diluting with water to give two and a half per cent. of kerosene.

Experiment 1.—At three p. m., a single leaf bearing many young lice was dipped in this fluid for a moment, and two hours later a number of the insects were taken from the leaf and examined with a microscope. All were evidently dead, and those on the leaf also

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*American Naturalist, Vol. XII, p. 661. J. Duncan Putnam in his admirable article on *Pulvinaria innumerabilis* published in Volume II of the Proceedings of the Davenport Academy of Sciences remarks, in a foot note to page 332, concerning this species: "I am very much inclined to think that *Platygaster lecanii*; described by Fitch in his 5th New York Report, as infesting *Lecanium quercitronis* may prove to be really a Coccophagus nearly allied if not identical with this species. The description applies too well, to easily believe that the two species belong to different families. In this event Dr. Fitch's reference to the Proctotrupidæ is of course wrong."

I am not able, however, to agree with Mr. Putnam in this matter, as the description by Fitch to which he refers states that the antennæ of his species are threadlike, with the joints slender, three times as long as thick, the last one not enlarged; whereas, in the specimens of *Coccophagus lecanii* bred by us from Pulvinaria, the antennæ are somewhat clavate, the joints less than twice as long as thick, and the last one is decidedly enlarged.

commenced to loosen at the margins and curl upwards. At eight on the following morning a single example only was found capable of slight motion.

Experiment 2.—This was a repetition of the first experiment with identical results except that all the plant lice examined on the morning of the 19th were absolutely dead.

Experiment 3.—In this case the same solution was applied to an infested leaf with a camel's hair brush with the same effects, all the bark lice being dead at eight the following morning.

Experiment 4.—On the 22d of the month a two and a half per cent. dilution of the kerosene emulsion was thrown with a force pump and a tubular nozzle upon a branch of a soft maple tree. The leaves were not as thoroughly wetted as desirable. Four days after about half the young bark lice were alive, although it is possible that the branch treated had been restocked by young from other parts of the tree, as the insects were still moving about and no precaution had been taken to prevent such migration.

Experiment 5.—On the same day a branch of soft maple attached to the tree was dipped in a two and a half per cent. dilution of kerosene, and on the following day three-fourths of the bark lice were dead. Four days after a few were still alive, but not enough to do any appreciable harm, and another application would doubtless have killed them all.

Experiment 6.—On the 29th the same experiment was tried with a five per cent. dilution of kerosene, the emulsion being made with whale oil soap, and common soap suds being used for dilution. Two days later the bark lice remaining on the leaves of this branch were all dead.

Experiment 7.—On the 29th, on the other hand, an application was made to a branch by dipping in a two and a half per cent. dilution, soap suds being again used as the diluent, and five days thereafter no considerable diminution in the number of living bark lice was apparent. It seems likely, however, considering the length of time that had elapsed between the experiment and the observation, that the branch had been restocked by young from other parts of the tree, as the lice were still actively crawling about.

Experiment 8.—On the 31st of the month the leaves of a branch of soft maple which was stocked with young bark lice were dipped in a five per cent. dilution of kerosene emulsion like that used in the preceding experiment. Five days later a few living bark lice still occurred upon the leaves, but nearly all had disappeared.

Experiment 9.—On the 6th August a similar experiment was made with a similar fluid, but containing ten per cent. of kerosene. The branch treated was not examined until nine days afterwards. The leaves were not at all injured by a solution of this strength. Many bark lice still remained upon them, but they had perhaps been restocked with living young.

In all the preceding observations the effect upon this bark lice was determined by microscopic examination, the sign of death relied

upon being the cessation of the heart's action. As the young were transparent when viewed by transmitted light, the motion of the heart of living specimens was easily detected.

Whale Oil Soap.

From the 19th to the 22d several experiments were tried by dipping the leaves in a solution of whale oil soap, or brushing their surfaces with it, but as the strength of the solution was not noted in these preliminary trials, I need only say that they were in all cases effectual.

Experiment 10.—On the 23d a branch of a tree infested with bark lice was dipped in a suds of whale oil soap containing a pound to a gallon of water, and on the morning of the following day the lice were all dead. Two days later, however, the leaves dipped in this solution showed signs of injury, the margins of most of them having blackened and dried up. Naturally the younger leaves at the tip of the branch were most severely injured, some having been almost wholly destroyed. On the 29th, nearly all the leaves had fallen off this branch.

Experiment 11.—On the 25th July, leaves were dipped in a solution containing a quarter of a pound of whale oil soap to the gallon, and on the 26th the bark lice were mostly dead, only a small percentage showing a feeble movement of the heart.

Experiment 12.—The above experiment was varied by using a solution double the strength just mentioned. On the following day all the specimens examined were dead.

Experiment 13.—On the 28th, experiment 12 was repeated with identical results, all the bark lice being dead two days later.

Experiment 14.—This was a repetition of experiment 11. The twigs were not examined, however, until five days afterwards. At this time, at least seventy-five per cent. of the bark lice upon the leaves were dead and many which were not killed seemed to have been driven from the leaves as if the soap suds were obnoxious to them. This was shown by their having fixed themselves upon the petioles and twigs, a fact not elsewhere observed so early in the season. The leaves were again very slightly injured at their margins, and a few, perhaps, eventually fell before their time.

Experiment 15.—A repetition of experiment 12. Five days after treatment not a single living bark louse could be found upon a leaf containing a hundred or so, all being brown and loosened, so that a touch dislodged them. The leaves, however, were slightly blackened at the margins, and some were doubtless injured enough to cause them to fall.

The experiments with whale oil soap were, consequently, less satisfactory than those with the kerosene emulsion, an application of the suds, strong enough to effect the purpose, being very likely to injure the leaves at least as much as the bark lice would have done.

Laundry Soap.

Experiment 16.—Three applications of strong solutions of laundry soap were made with a brush to infested leaves, from the 19th to the 22d July, with the effect to destroy all the bark lice, occasionally, however, with trifling damage to the leaves. The effect of these applications apparently differed but little from those of the whale oil soap.

Pyrethrum.

Experiment 17.—Although expecting nothing from the application of pyrethrum, we made a few experiments with it, commencing July 19. As they were all entirely inefficient, the results need not be given further than to say that the fresh pyrethrum powder suspended in water in quantities varying from a tablespoonful to the gallon up to an excessive proportion was applied by brushing and dipping, without any effect whatever. Pure pyrethrum was also dusted upon the leaves without result.

Carbolic Acid.

Experiment 18.—July 19, leaves infested with the young bark lice were thoroughly wetted with carbolized water (a teaspoonful of the pure liquid acid to the gallon) and examined five hours later. The bark lice were all alive. This experiment was twice repeated, both in the laboratory and the field, with only negative results.

A few additional experiments were made with tobacco water (one-half pound tobacco to a gallon of water); with hellebore (one ounce to the gallon); and with a weak solution of caustic soda,—in all cases without any favorable result, every individual being apparently alive in from one to three days after treatment.

As a general result of the above series of experiments we may say that a kerosene emulsion diluted with soap suds to a strength of from two and a half to five per cent., was found effective during the month of July and did not injure the leaves. This was the only substance experimented with which gave any promise of usefulness, with the exception of the whale oil and soaps, which were subject to the drawback already mentioned; that is the liability to injure the leaves if used in a solution strong enough to destroy the bark lice. Possibly if it were washed off shortly after application, as recommended by Dr. Lintner, the injurious result might be prevented, but this would too greatly increase the trouble and expense of the application.

Washing off the Females and Egg Masses with Water.

From correspondents in Northern Illinois, I learned that late in June, the practice became somewhat general of washing off the egg masses and the outworn bodies of the females with jets of water from the hydrants, throwing the water into the tree by means of a hose, but I have not yet been able to learn with what result. This method was, apparently, usually applied under the mistaken

notion that the principal injury to the trees was done by these last year's females, and that if they were removed the damage would be arrested. The real injery, I need not say, is done later in the season by the young hatching from the egg masses which make these females so conspicuous in spring and early summer. It is possible, however, that the method is a valuable one, as the washing away of the eggs before hatching, may not improbably result in the destruction of many of them. The young which hatch upon the ground would doubtless, most of them, make their way back to the tree, but if the rubbish beneath the tree were raked and burned after the egg masses had been dislodged by the water, the multiplication of the pest might probably be kept below the limit of injury.

[Since the above was written, I have received from Mr. S. M. Dunning, of Chicago, who thoroughly tried the hydrant method last June, twigs of a maple tree from which the egg masses had been carefully and completely washed off. The under sides of these twigs were well covered, in March, 1885, with half grown females,—scarcely, if at all, less abundantly so than was to have been expected if no treatment had been applied. The nearest other maples were across a dusty city street, and it is scarcely likely that the young were conveyed so far. A box elder in the same lot, which was also attacked by the bark lice, but not treated, may have divided its parasites with the maple; but, curiously, this tree had this spring fewer lice than the maple above mentioned. It is, therefore, improbable that the mere dislodgement of the egg masses with the water jet had any real effect on the numbers of the young lice. Indeed, it may have easily done more harm than good by destroying within the egg masses the larvæ of the Coccinellidæ to whose multiplication we have to look for the principal check on the increase of the next brood. This is, perhaps, the explanation of the inferior abundance of bark lice upon the box elder, as just mentioned. Destruction of the egg masses by burning, after dislodging them with water, seems to be necessary to any promise of success by this method. Further experiment is needed, however, and will be undertaken the coming season.]

2. The Oblique-Banded Leaf Roller.

(*Cacœcia rosaceana*, Harris.)

This nearly omnivorous species, (not hitherto reported, however, from the maple), was by us found rolling the leaves of *Acer dasycarpum* in May, pupæ and larvæ collected on the 20th of that month emerging from July 9 to 13.

3. Pandemis lamprosana, Robs.

Order Lepidoptera. Family Tortricidæ.

(Plate XI. Fig. 3.)

Among the leaf rollers upon the maple, collected May 10, was one of which we kept no description, which resulted in an imago of *Pandemis lamprosana*.

4. *Aleurodes aceris*, n. s.

Order HEMIPTERA. Family ALEURODIDÆ.

(Plate XI, Figs. 4 and 5.)

I have noticed, for several years, a peculiar bark louse upon the leaves of the maple, but have not bred it until the present year. The fully developed pupal scale is oval in general outline, somewhat lyrate, broadest posteriorly, contracted in front of the middle. Margins entire, surface densely granulated. The color is chocolate, mottled with white, the white varying in amount and tending to form three transverse bands. The central segmented area is usually irregularly mottled with white, and a quadrate patch, including the vent, is almost always brown; but, otherwise, the color may vary from nearly uniform brown to almost white. Outline sometimes slightly emarginate posteriorly. Length, .095 of an inch; greatest width, .045; width at anterior fourth, .036.

The imago is pale yellow throughout; legs and abdomen paler; wings milky white; rostrum black at the extreme tip; veins yellowish; first joint of the antennæ scarcely longer than wide, the remaining joints filiform, the second nearly as long as the four following and about four times as long as the first, the fourth longer than the third, the third and fifth about equal, the sixth fusiform.

At Tamaroa, in Southern Illinois, soft maple trees were found badly infested by this bark louse, but elsewhere it has occurred in only trivial numbers. There are apparently two broods of this species in a year, scales collected in August, 1883, emerging April 10 to 24, 1884, and others, collected during the present summer, emerging August 4. From these larvæ several hymenopterous parasites belonging to the genus Elaptus escaped September 6, the species of which is apparently new.

Elaptus aleurodis, n. s. Plate XI. Fig. 6. Female. Length .03 of an that of inch; the head .005 inch; front wings .032 of an inch long and .001 inch wide; posterior wings .0032 inch wide at the widest point; antennæ as long as the head and whole body; scape stout, arcuate, rising to the top of the head, about as long as the three following joints, nearly smooth, as is also the second joint; remaining joints densely pilose; the club not jointed, as long as the three joints preceding; first joint obconic, second about the same length but narrower. Color black, surface shining, abdomen alutaceous, head and thorax punctured, antennæ yellow, legs entirely yellow, femora and tibiæ of the middle and posterior legs black, their tarsi yellow.

Described from three specimens bred from *Aleurodes aceris*.

5. *Lygus invitus*, Say.

Order HEMIPTERA. Family CAPSIDÆ.

(Plate XII. Fig. 1.)

Brief mention may properly here be made of a species whose injuries to vegetation have not hitherto been serious, as far as known,

but which deserves attention as the near relative of one of the most injurious horticultural species (the tarnished plant bug), and also because, from its own abundance and habits, it may well become the author of serious mischief.

Although not agreeing precisely with any descriptions of Capsidæ accessible to me, I have little doubt, after careful study of about forty specimens collected in June, that the species is that described by Say as *Capsus invitus*. It differs materially from Say's original descriptions, but corresponds closely in most particulars with the description of a type specimen of Say's, published by Uhler in his notes on the Heteroptera in the collection of Dr. Harris,* varying from that only in some color characters of little moment in so variable a genus.

DESCRIPTION.

The following description is condensed from that of Uhler, modified with respect to color to conform to our own specimens.

General color pale obscure yellow, varying to yellowish green. Antennæ and transverse carina at base of head very slender, the former nearly as long as the hemelytra. Surface of head polished, impunctured, clothed with short hairs. Tylus slender, short. Eyes large, prominent. Pronotum smooth, very convex, sparingly hairy, finely, densely and mostly confluently punctured, the punctures forming obscure transverse rugosities. The head and fore part of the thorax are slightly darker yellow, the antennæ are sometimes pale throughout, sometimes embrowned at tip and also at tip of second joint. A broad band on the pronotum, a little within the margin, extends backwards along the inner edge of the clavus, is continued as a dusky shade through the middle of the membrane, deepest along the inner edge of the inner cell, and extends distally into an indefinite dusky shade. This line is intersected at the tip of the corium by a transverse band of the same color extending to the edge of the hemelytra. When the wings are closed, these marks give the appearance of a median black stripe crossed at the tip of the corium by a black band, and forking at the scutellum. In the darker colored specimens the pronotal bands are frequently connected by a basal shade. The posterior half of the larger cell of the membrane is usually white. In many yellowish specimens the cuneus alone is green. The posterior thighs are commonly infuscate on the distal half, and the anterior tibiæ are often brown at tip. Length to tip of hemelytra 6 mm. Humeral breadth 1.66 mm.

On the 12th May the younger leaves of many of the common soft maples (*Acer dasycarpum*) near Normal, were observed to be curled, and specked with numerous semi-transparent spots, evidently the work of the larvæ of this capsid, found abundantly upon the affected leaves. On the 30th May, specimens collected were all of the second and third stages. On the 1st June, the first imagos were seen in the breeding cages and on the trees. By the 5th of that month nearly all the specimens collected had transformed to the imago, and the experiment was not carried farther.

* Proceedings of the Boston Society of Natural History, Vol. XIX, p. 407.

ARTICLE VII. INSECTS INJURIOUS TO THE ELM.

1. The Elm Borer, (*Saperda tridentata*, Oliv.)

Order Coleoptera. Family Cerambycidæ.

(Plate XII. Fig 2.)

For several years past my attention has been attracted by the gradual decay and death of the rows of white elms (*Ulmus americana*) in the towns of Normal, Bloomington, and Champaign. The difficulty with the trees commonly commences, to declare itself from the middle of summer to autumn, when the leaves, first upon the terminal twigs and then upon the larger branches, are seen to stop their growth, change their color, and ultimately to fall. This loss is naturally followed speedily by the death of the branches themselves, as is clearly evident the following spring, when these remain black and lifeless while the rest of the tree is putting on its foliage. Usually the higher branches of the tree are those first affected, but the whole top soon seems to blight, and in a year or two the tree perishes utterly. This difficulty, commencing here and there, extends slowly from tree to tree along the rows, finally inevitably destroying every tree of this species in the immediate vicinity.

In the autumn of 1883, I directed an assistant, Mr. Webster, to dig up a tree which had nearly died in this manner during the summer, and to carefully examine the larger roots, the trunk, and all the branches, with a view to ascertaining, if practicable, the cause of the difficulty. The roots were found unaffected, but on peeling the bark from the trunk, about half-grown larvæ of *Saperda tridentata* appeared in considerable numbers in the still living parts of the wood, and those of *Magdalis armicollis* (Plate XI. Fig. 3) were abundant where the bark and wood were already dead. The manner in which the bark had been mined and burrowed by the Saperdas, gave sufficient evidence of the cause of the death of the tree, the borers having again and again completely girdled the trunk.

Both the trunk and branches of this tree were cut up in lengths and boxed for the purpose of determining the details of the life history of the species. The specimens were boxed Aug. 8, the cracks of the boxes being closed by pasting over them strips of paper, and each having left a glass covered opening in the top, to which it was assumed that the insects emerging would be attracted. Later, this cover was removed, and a glass jar was inverted over the opening.

Nothing emerged until the following spring, except a single parasite taken September 14. On the 9th April, living larvæ of Saperda were found still within the wood, but no imagos had appeared in the boxes, neither were any pupæ discovered. On the 17th of that month, both larvæ and pupæ were detected, and on the 2d of May, the first imagos appeared, three in number. On the third another imago emerged, on the 5th five more, on the 7th eighteen, on the 8th eleven, and on the 12th twenty-three, this being the largest number taken from the boxes at once. Beetles continued, however, to emerge at frequent intervals until the 22d June, at which time the last appeared, one hundred and eighteen in all, having been taken alive. On the 15th September, the boxes were opened finally, thoroughly searched, and fifty-three more dead Saperdas were found. The boxes in which these specimens transformed, had been kept under cover, but at the natural temperature of the air.

Although the elm borer has evidently been for several years both numerous and increasing in the neighborhood where this tree was destroyed, the amount of parasitism developed by the experiments was quite insignificant, only eight parasitic insects, belonging to three species, appearing in the boxes as against the one hundred and seventy-one examples of the adult borer; and, indeed, as the same pieces of wood contained a great host of the larvæ of *Magdalis armicollis*, from which multitudes of imagos of this species emerged during this spring, it is impossible to say that some or most of this small number of parasites may not have escaped from the latter species.

Since the time of Harris, the elm tree borer has been well known as a destructive enemy of this most magnificent and beautiful of the shade trees of our towns and cities. It seems first to have attracted attention as an enemy of the elm in Boston, in 1847, at which time the trees on the Boston common were found by Harris to have suffered terribly from the ravages of this insect. "Several of them," he says, "had already been cut down, as past recovery; others were in a dying state, and nearly all of them were more or less affected with disease or premature decay. Their bark was perforated, to the height of thirty feet from the ground, with numerous holes, through which insects had escaped; and large pieces had become so loose, by the undermining of the grubs, as to yield to slight efforts, and come off in flakes. The inner bark was filled with the burrows of the grubs, great numbers of which, in various stages of growth, together with some in the pupa state, were found therein; and even the surface of the wood, in many cases, was furrowed with their irregular tracks. Very rarely did they seem to have penetrated very far into the wood itself; but their operations were mostly confined to the inner layers of the bark, which thereby became loosened from the wood beneath."

The borers, (the larvæ of the beetles) are similar in form and general appearance to the notorious round-headed borer of the apple, belonging, indeed, to the same genus. They rarely exceed three-fourths of an inch in length, are destitute of feet, and have the usual enlargement of the first segment of the body immediately behind the head. The body is white, subcylindrical, a little flattened, with the lateral fold of the body rather prominent; end of

the body flattened, obtuse, and nearly as wide at the end as at the first abdominal ring. The head is one-half as wide as the prothoracic ring, being rather large. The prothoracic segment, or that next to the head, is transversely oblong, being about twice as broad as long; there is a pale dorsal corneous transversely oblong shield, being about two-thirds as long as wide, and nearly as long as the four succeeding segments; this plate is smooth, except on the posterior half, which is rough, with the front edge irregular and not extending far down the sides. Fine hairs arise from the front edge and side of the plate, and similar hairs are scattered over the body and especially around the end. On the upper side of each segment is a transversely oblong ovate roughened area with the front edge slightly convex, and behind slightly arcuate. On the under side of each segment are similar rough horny plates, but arcuate in front, with the hinder edge straight.

The beetle resulting from this larva is of a dark brown color, with a tint of gray, owing to a thin coating of very short down. It is ornamented with a curved line behind the eyes, two stripes on the thorax, and a three-toothed or three-branched stripe on the outer edge of each wing-cover of a rusty red color. There are also six black dots on the thorax, two above, and two on the sides; and each of the angles between the branches and the lateral stripes of the wing-covers is marked with a blackish spot. The two hinder branches are oblique, and extend nearly or quite to the suture; the anterior branch is short and hooked. Its average length is about half an inch; but it varies from four to six-tenths of an inch. The males are smaller than the females, but have longer antennæ.

From the present appearance of the elms throughout the towns of Central Illinois where I have had an opportunity to examine their condition, and from the rapid progress which this pest has made among them during the last two or three years, it seems extremely likely that it will totally exterminate the trees unless it be promptly arrested by general action. The only remedy available is unquestionably the destruction of affected trees in autumn and winter before the beetles have a chance to emerge from the trunks. In towns this measure should usually be taken by the authorities, since individual action could not be depended on to more than palliate the difficulty. If every elm which is in the unhealthy condition above described, and which, upon examination, is found to harbor these borers beneath the bark, were cut down in autumn and burned before spring, the multiplication of the borer might be effectually checked; but if the destruction of the trees be postponed until as late as May, a part of all of the beetles maturing each year would escape to carry the mischief elsewhere.

2. The Elm Plant Louse.

(*Schizoneura rileyi*, Thos.)

Order Hemiptera. Family Aphididæ.

Finding an elm at Normal seriously infested by this louse, and apparently upon the point of death from the effects upon its foliage,

I tried the experiment of applying pyrethrum for the destruction of the insect. A large branch was dusted with a mixture of one part of pyrethrum to ten of flour, at 9:30 a. m., July 4, and soon after the lice began falling from the twigs. At 6 p. m. only a few remained, and by 8 a. m. of the second day thereafter all had fallen off and were lying dead upon the table. Spraying the foliage of these trees with water in which pyrethrum was suspended in the proportion of about a tablespoonful to a gallon of water would, consequently, in all probability, destroy the lice, or at least so effectually check their multiplication as to prevent injury to the trees.

3. An Elm Bark Louse.

(*Lecanium*, sp.)

Order Hemiptera. Family Coccidæ.

On the twigs of the white elm, at Normal, we found, this last season, a large brown bark louse very similar in size, shape and general appearance to the maple Pulvinaria previous to the appearance of the cottony egg mass beneath the body of the female, but differing especially in the fact that the eggs were not enclosed in the waxy filamentous masses or nests characteristic of Pulvinaria.

As we obtained only the adult female, we had not the material for determining or describing the species. The matured scales are nearly circular, 5 mm. in diameter, vaulted, emarginate before and behind, the upper surface more or less shining, dark brown, irregularly pitted on the central area, (where, however, it is nearly smooth), and deeply and irregularly punctured on the sides,—below the punctures irregularly rugose. The eggs are oval, .099 mm. in length by .048 mm. in transverse diameter. Beneath females obtained July 2, were eggs in various stages of development, young which had just hatched, and those which had just passed the first moult.

4. The Three-Banded Leaf Hopper.

(*Typhlocyba tricincta*, Fitch.)

Order Hemiptera. Family Coccidæ.

About the middle of June, this pale yellow leaf hopper, distinguished by two transverse dusky bands, (one across the middle and one at the tips of the wing covers), and a dusky cloud upon the scutellum, was abundant enough upon the leaves of the white elm, at Normal, to do considerable damage. This species, described by Fitch in his Third Report as State Entomologist of New York, (p. 74), was originally found by him, in abundance, on raspberry and currant bushes, and on grape vines.

ARTICLE VIII.—BRIEF MISCELLANEOUS NOTES.

1. Black Locust.

(*Nematus robiniæ*, n. s.)

(Plate XII. Fig. 5.)

From a number of saw fly larvæ found infesting the black locust (*Robinia pseudacacia*) at Normal, we bred during the latter part of July a small saw fly related to *Nematus bivittatus* and *aureopectus*, but apparently undescribed.

Body stout, palè brownish yellow; mesothorax with a black vitta upon each side; metathorax with a transverse black band continuous with the posterior extremities of the mesothoracic stripes; tergum blackish with the sides and posterior margins of the segments of the general color; prothorax between the ends of the mesothoracic stripes a little darker brown; head slightly darker than the body, with a quadrate black spot upon the occiput, extending forward to include the ocelli. This area is slightly shining, but the adjacent surfaces of the head are dull, punctured, and rather densely pubescent. Antennæ longer than the head and body, third and fourth joints equal; clypeus emarginate in front. The under parts and legs are uniform pale yellow brown, except the tibiæ and tarsi of the posterior pair which are dusky, and the genital valves of the female, which are black. Wings hyaline, veins fuscous, costa and stigmata yellowish, second submarginal cell slightly angled at the recurrent nervules, of which there are two about equally removed from the two extremities of the cell. First submarginal quadrate, distinct; posterior margin of wing behind the lanceolate cell slightly tinged with yellowish.

Length of body 4 mm.; expanse 10 mm.

Described from a single female.

The larva from which this specimen was bred entered the ground July 8, the imago emerging on the 26th.

2. Onion.—At Champaign, July, 1883, my attention was called by Prof. Burrill, to some hairy larvæ that were destroying onions in his gardens, as far as their numbers enabled them. Although this seemed to be the larva of *Spilosoma virginica*, Fab., its colors were somewhat unusual, and we bred it for identification; but the imagos proved to be unquestionably that species.

3. Egg Plant.—At Godfrey, September 25, the leaves of egg plants were found badly riddled by a small flea beetle, *Crepidodera cucumeris*, Harris.

4. Larch.—In June, the foliage of the larches in the grounds of the University at Normal, were seriously affected by the red spider (*Tetranychus telarius*, L.,) some of the trees seeming likely to die. On one of those worst infested we tried the effect of spraying with a kerosene emulsion made with soap, and diluted to contain two and a half per cent. of kerosene. The insects were greatly reduced in number by a single application, but not all killed. The trees soon revived appreciably as compared with those not treated.

5. Willow.—The leaves of the willow at Normal were generally infested both in 1883 and 1884, by the larvæ of *Apatela oblinita*, those collected July 6 pupating on the 11th and emerging on the 23th.

Orgyia leucostigma, Smith, was rather abundant on the willow in the University grounds at Normal.

Larvæ of *Plagiodera lapponica*, L., taken on the willow at Normal, June 24, commenced to pupate July 1, and to emerge on the 3d, the last of about sixty appearing on the 8th.

The adult, *Crepidodera helxines*, L., was found repeatedly throughout May in Central and Southeastern Illinois, devouring the leaves of willows, and scarcely less commonly upon the Lombardy poplar and the balm of Gilead, doing decided injury to young trees in the nurseries.

6. Cherry.—From my friend, Dr. E. R. Boardman, of Elmira, Stark county, I learned on the 9th June that the common willow slug (*Nematus ventralis*, Say) had almost completely defoliated a fine tree of wild cherry on his grounds. The species has long been known as an enemy of the willow, but has not been heretofore reported as injurious to any fruit tree.

During this month of June the cherry slug (*Selandria cerasi*, Peck) was especially abundant, completely whitening the leaves of many trees, and doubtless killing some. The efficacy of hellebore for the destruction of this insect is well known, but as the use of so poisonous a substance is often unadvisable, we experimented somewhat carefully with two other insecticides—the kerosene emulsion and pyrethrum, a five per cent. dilution of the former, containing two and a half per cent. of kerosene, and one ounce to a gallon of the latter. We found these in both cases entirely effective, only a small percentage of the larvæ treated escaping.

7. Currant and Gooseberry.—The green apple leaf hopper (*Empoa albopicta*, Forbes,) was seen by us upon the currant and gooseberry at Normal, in numbers sufficient to do serious injury, causing the leaves to curl and shrivel.

A number of leaf rollers of the currant, collected at Normal on the 12th May,—white, smooth, with shining jet black head, mouth parts, and cervical shield, prothoracic segment except the shield reddish with two oblong black tubercles upon the sides of this segment, the anterior legs black, tarsi of the others dusky,—emerged

Plate III.

Fig. A. Side view of the female Hessian Fly, greatly enlarged.

a, three joints taken from the middle of the antenna of the female; a^{1}, the three terminal female antennal joints; a^{11}, the four basal, and a^{111}, the two terminal male antennal joints; *b*, a maxillary palpus; *c*, scales from the body and wings; *d*, *e*, side and vertical view of the last joint of the foot, showing the claws and foot-pad or pulvillus between them, and the scales on the joint.

Fig. B. Larva magnified with the "breast-bone" in the second ring next to the head.

B*a*, the breast-bone highly magnified; B*b*, head from beneath enlarged; B*c*, larval spiracle and its tubercle and trachea leading from the spiracle.

Fig. C. Side and front view of the pupa or chrysalis. The abdomen of the side view is rather long, as the insect, when drawn, was just emerging from the semi-pupa stage which it assumed December 1.

Fig. D. The flaxseed, puparium, or pupa case.

The line by the side of the complete figures denotes the natural length of the insect. (From 10th Report.)

Plate IV.

Fig. 1. Parasite of the Hessian Fly, *Pteromalus pallipes;* magnified eight diameters. (Original.)

Fig. 2. Parasite of the Hessian Fly, *Pteromalus fulvipes;* magnified seven diameters. (Original.)

Fig. 3. The Wheat Midge, *Diplosis tritici: a*, male; *b*, female; a^{1}, natural size; *c*, wing, greatly enlarged; *d*, antennal joints of male; *e*, do., of female; *f*, ovipositor; *g*, eggs, greatly magnified; *h*, flower of wheat, showing larvæ on kernel; *i*, larva in repose; *j*, do., crawling; j^{1}, natural size; *k*, enlarged view of anterior end when moving; *l*, posterior end, with teeth protruding to aid in motion. (After Fitch.)

Fig. 4. The Wheat Bulb Worm, *Meromyza americana*, larva; magnified sixteen diameters. (From 13th Report.)

Fig. 5. Pupa enclosed in puparium; magnified thirty diameters. (From 13th Report.)

Fig. 6. The same; ventral view. (From 13th Report.)

Fig. 7. Egg; magnified sixty diameters. (From 13th Report.)

Fig. 8. Imago, or adult fly; magnified twelve diameters. (From 13th Report.

Plate V.

Fig. 1. The Grass Worm, *Laphygma frugiperda: a*, adult larva; *b*, head, front view; *c*, dorsal view of abdominal segment; *d*, lateral view of abdominal segment.

Fig. 2. Imago of the Grass Worm: *a*, typical form; *b*, *c*, varieties.

Fig. 3. Grain Leaf Hopper, *Cicadula nigrifrons*; magnified five and three-fourths diameters; front wing and front view of head more highly magnified. (Original.)

Fig. 4. Grain Leaf Hopper, *Cicadula quadrilineatus;* magnified five and three-fourths diameters; front wing and front view of head more highly magnified. (Original.)

Fig. 5. Sketch of wheat field infested by the Grass Worm, showing areas denuded.

Plate VI.

Fig. 1. The Yellow Sorghum Aphis, *Chaitophorus flavus*, wingless viviparous female; magnified twenty-five diameters. (From 13th Report.)

Fig. 2. *Chaitophorus flavus*, pupa, dorsal view. (From 13th Report.)

Fig. 3. The same, side view. (From 13th Report.)

Fig. 4. *Chaitophorns flavus*, winged viviparous female; magnified twenty diameters; *a*, antenna of the same more highly magnified. (From 13th Report.)

Fig. 5. *Cymatophora crepuscularia.* (Re-drawn by Mrs. Garman from Packard's Monograph.)

Fig. 6. Omitted.

Fig. 7. Clover Mite, *Bryobia pratensis;* magnified twenty-one diameters. (Original.)

Fig. 8. Apple Leaf Roller, *Cacœcia rosaceana;* larva, pupa, and moth.

Fig. 9. *Tortrix pallorana.* (Original.)

Plate VII.

Fig. 1. Strawberry Worm, *Emphytus maculatus:* 1, ventral view of pupa; 2, side view of same; 3, enlarged sketch of perfect fly, the wings on one side detached; 4, larva crawling, natural size; 5, perfect fly, natural size; 6, larva at rest; 7, cocoon; 8, enlarged antenna, showing joints; 9, enlarged egg. (After Riley.)

Fig. 2. The Tarnished Plant Bug, *Lygus lineolaris*, adult; magnified fifteen diameters. (From 13th Report.)

Plate VIII.

Fig. 1. The Tarnished Plant Bug, *Lygus lineolaris*, fourth stage; magnified fifteen diameters. (From 13th Report.)

Fig. 2. The same, second stage; magnified fifteen diameters. (From 13th Report.)

Fig. 3. The same, first stage; magnified fifteen diameters. (From 13th Report.

Plate IX.

Fig. 1. The Strawberry Root Worm, larva of *Scelodonta pubescens.*

Fig. 2. Pupa of *Scelodonta pubescens.*

Fig. 3. Imago of *Scelodonta pubescens;* magnified sixteen diameters.

Fig. 4. The Vine-Loving Fruit Fly, *Drosophila ampelophila.* (Re-drawn by Mrs. Garman from Comstock's Report.)

Fig. 5. Egg, larva, and pupa of the same. (Re-drawn by Mrs. Garman from Comstock's Report.)

Fig. 7. The Blackberry Leaf Miner, *Metallus rubi*; magnified three diameters. (Original.)

Plate X.

Fig. 1. *Pyrrhia umbra.* (Original.)

Fig. 2. Raspberry Plume Moth, *Oxyptilus delavaricus;* magnified. (Original.)

Fig. 3. Moth of the Speckled Cutworm, *Agrotis c-nigrum.* (Original.)

Fig. 4. *Biston ypsilon.* (Original.)

Fig. 5. The Apple Leaf Skeletonizer, *Pempelia hammondi: a,* larva, natural size; *b,* one of middle segments of larva, magnified; *c,* head and first three segments, dorsal view; *d,* adult moth.

Fig. 6. Yellow Jumping Pear Louse, *Trioza pyri;* magnified seven diameters. (Original.)

Fig. 7. The Willow Saw Fly, *Dolerus arvensis.* (Original.)

Plate XI.

Fig. 1. The Soft Maple Bark Louse, *Pulvinaria innumerabilis: a,* twig with adult fly and egg masses; *b,* mature female scale seen from above; *c,* mature female scale seen from beneath.

Fig. 2. The same in autumnal condition: *a,* twig with half-grown female scales; *b,* autumnal female scales seen from above; *c,* the same seen from beneath.

Fig. 3. *Pandemis lamprosana.* (Original.)

Fig. 4. *Aleurodes aceris,* mature scale; magnified five and a half diameters. (Original.)

Fig. 5. Imago of the above. (Original.)

Fig. 6. *Elaptus aleurodis;* magnified twenty-three diameters. (Original.)

Plate XII.

Fig. 1. *Lygus invitus;* magnified four diameters. (Original.)

Fig. 2. The Elm Borer, *Saperda tridentata;* natural size. (Original.)

Fig. 3. *Magdalis armicollis;* magnified. (Original.)

Fig. 4. Parasite of Corn Aphis, *Adialytus maidaphidis: a*, first, second, and third articles of antenna of female; *b*, distal article of antenna of female; *c*, mandible of female; *d*, maxilla and palpus; *e*, four distal articles of antenna of male; *f*, hind leg of female; *g*, valve of ovipositor; *h*, fore wing of female; *i*, hind wing of female; *j*, abdomen of female; *k*, abdomen of male, side view; *l*, ovipositor, separated from valves; *sh*, sheath; *la*, lancelet; *m*, larva of Adialytus, taken from body of Corn Aphis in December. (Original.)

Fig. 5. *Nematus robiniæ;* magnified three diameters. (Original.)

Plate I.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 6.

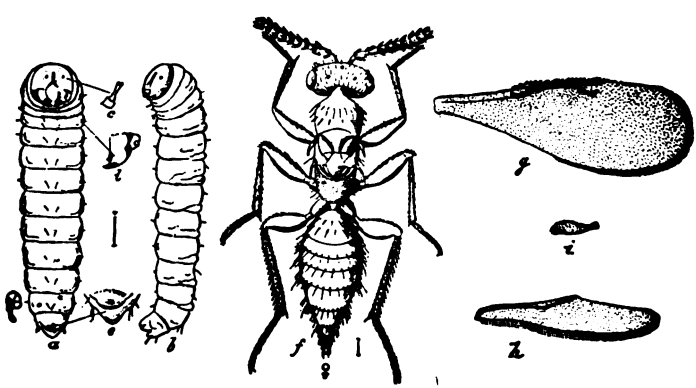
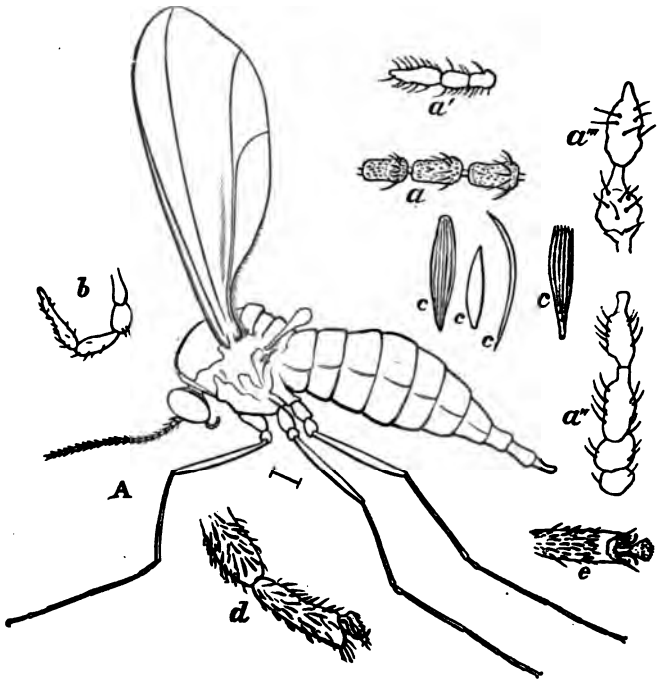


Fig. 5.

Plate II.

PLATE III.



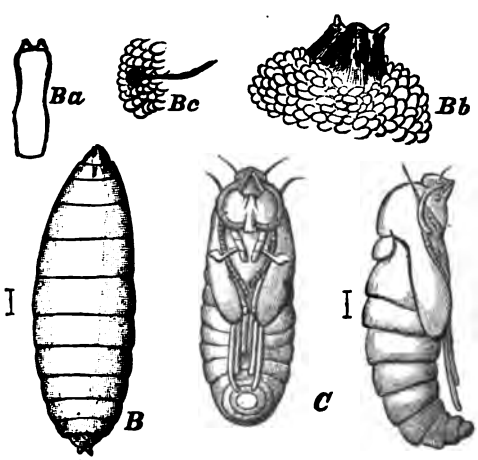


Plate IV.

Fig. 1.

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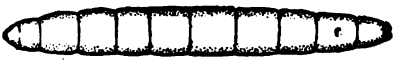

Fig. 4.

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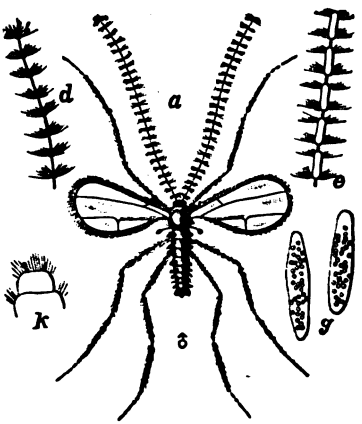

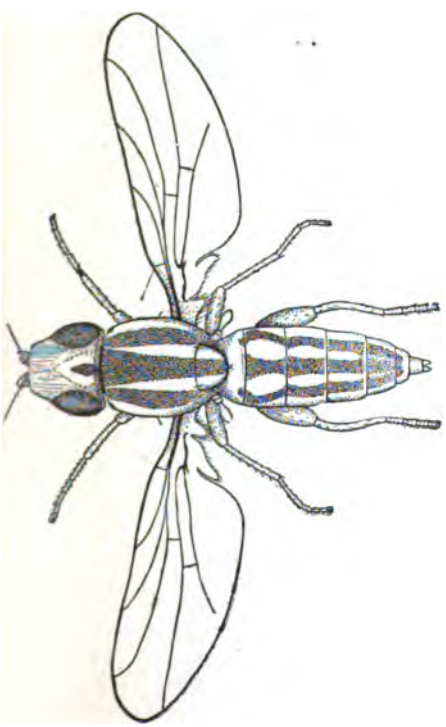

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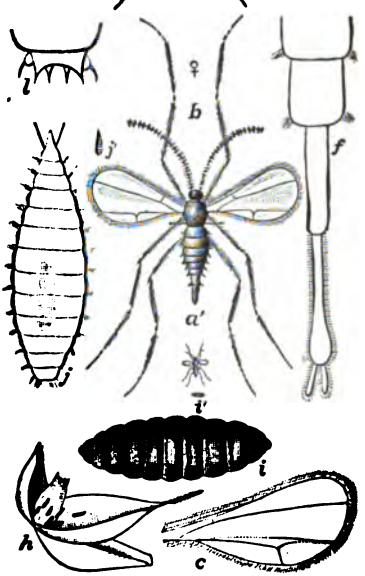
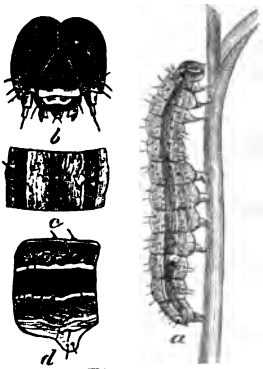


Fig. 3.

Plate V.



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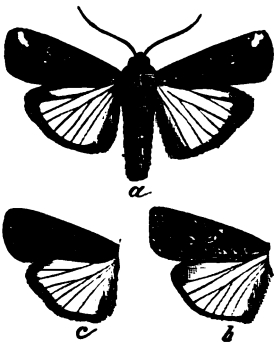

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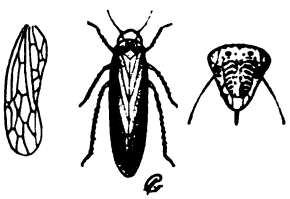

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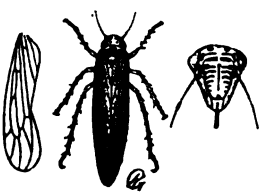

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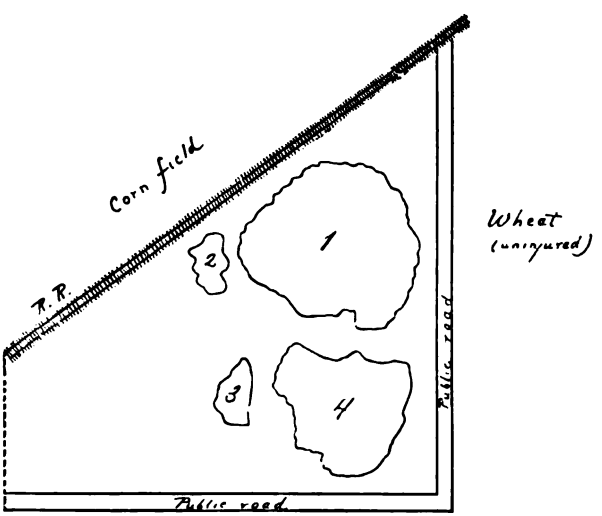

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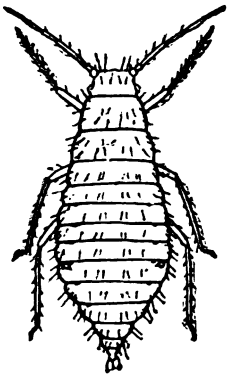

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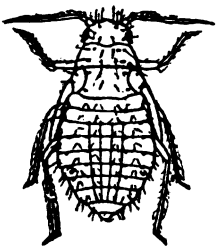

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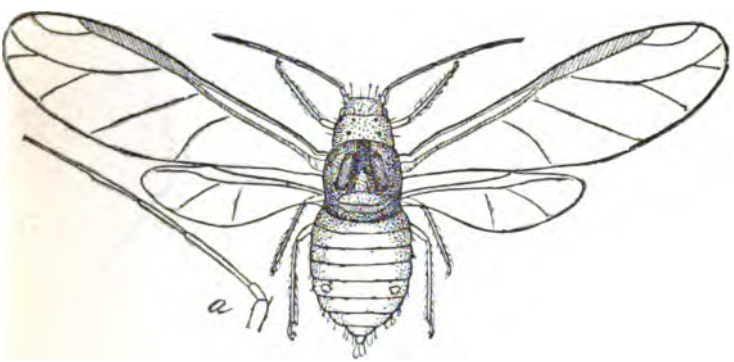


Fig. 4.

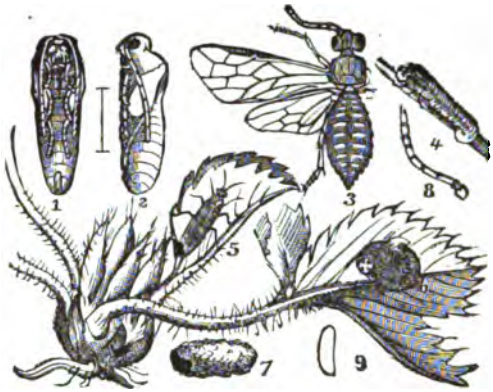
Fig. 5.

Fig. 7.

Fig. 8.

Fig. 9.

Plate VII.



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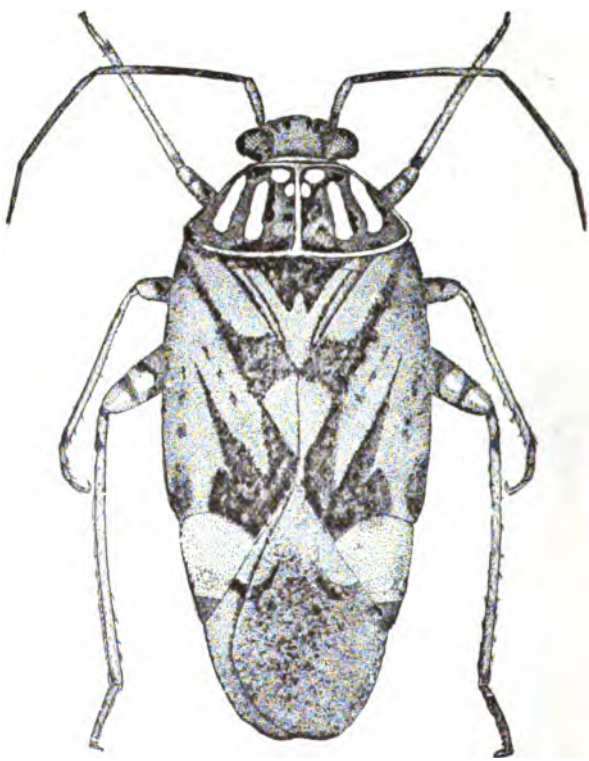
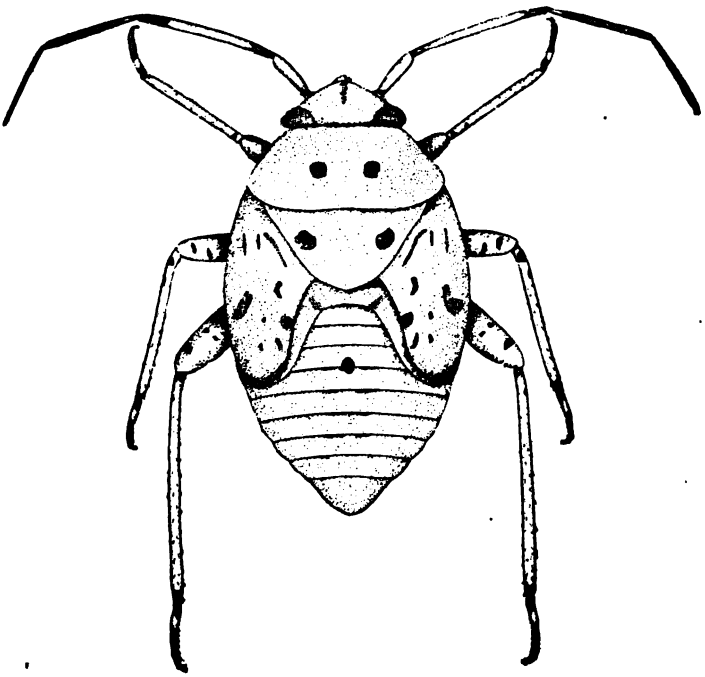


Fig 2.

Plate VIII.



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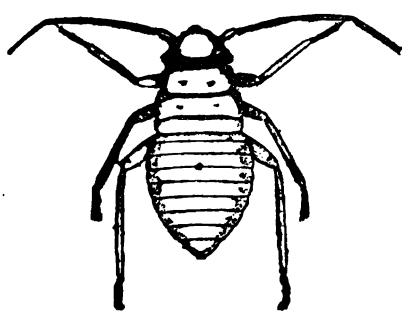

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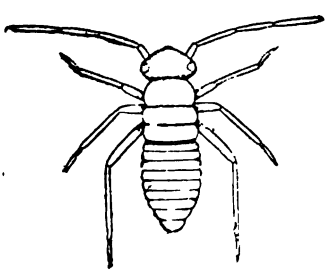

Fig. 3.

Plate IX.

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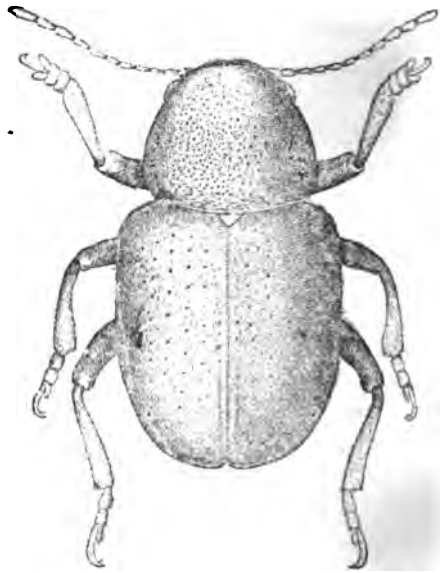

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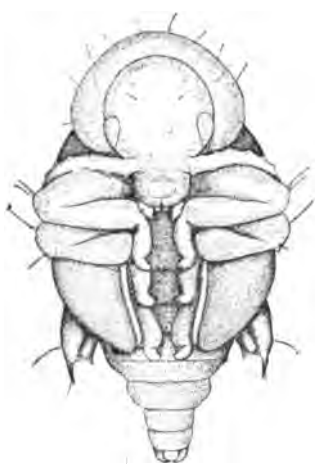

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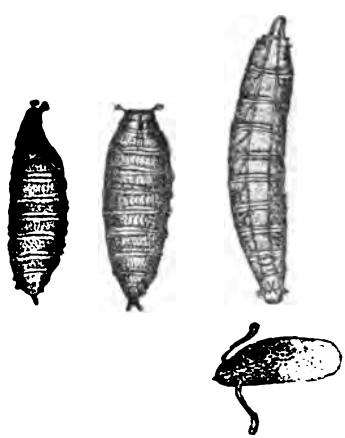

Fig. 5.

Fig. 7.

Plate X.

Fig. 1.

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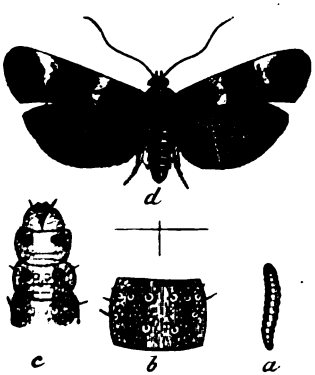
Fig. 4.

Fig. 6.



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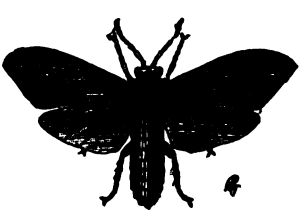
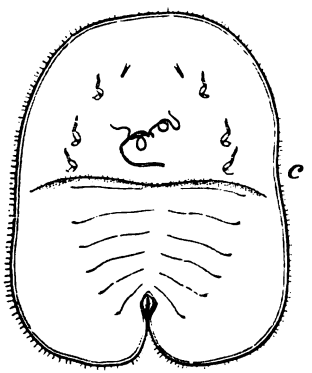
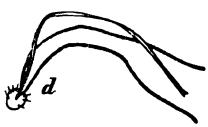


Fig. 7.

Plate XI.





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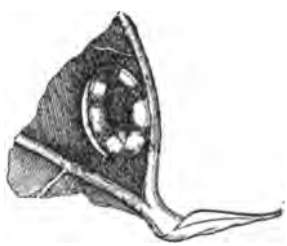

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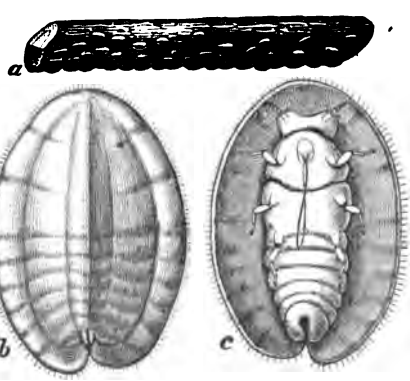

Fig. 2.

Fig. 5.

Fig. 6.

Plate XII.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 5.

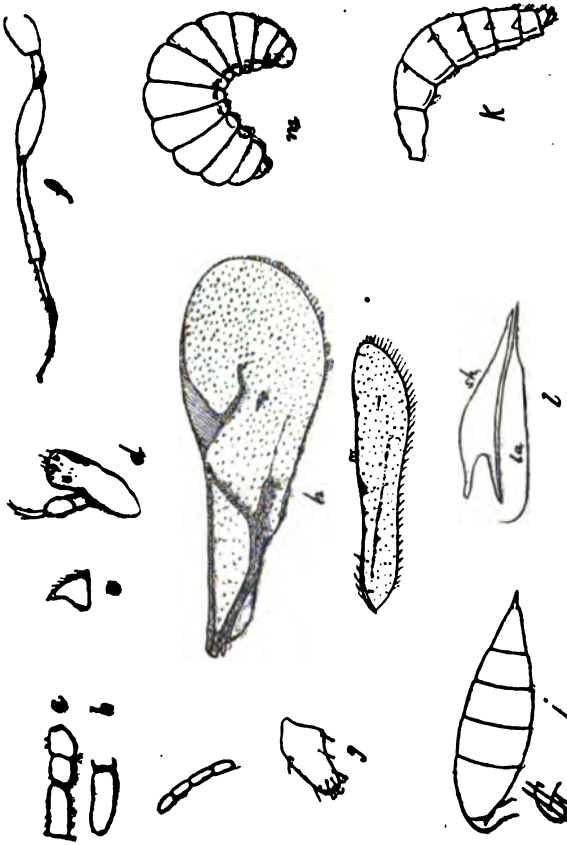

Fig. 4.

ERRATA

Page 3, line 10 from bottom, for infected, read infested.

Page 5, line 6 from bottom, after 1883, insert, at which time.

Page 6, line 6 from bottom, for grower, read fields.

Page 14, line 8 from bottom, for S, read Y; line 9 from bottom, for S-shaped, read Y-shaped; line 18 from bottom, for larvæ, read larva.

Page 16, line 22, for attack, read attacked.

Page 17, line 7, for secured, read secreted.

Page 18, line 9, after history, add, in Papilio, Vol. III, p. 99.

Page 22, foot note, for 63, read 67; line 10 from bottom, after *nobilis*, insert Harris; line 14 from bottom, for Tettigonidæ, read Jassidæ.

Page 23, lines 21 and 27, for Caloptenus, read Pezotettix.

Page 24, line 21 from bottom, for the first when, read where.

Page 26, line 1, for subæqual, read subequal; line 21, for viviporous, read viviparous; line 13 from bottom, for differs, read differ.

Page 27, line 18 from bottom, for their stalks, read the more advanced stalks.

Page 28, line 17, for evidently, read evident.

Page 29, line 12 from bottom, for the first the, read they.

Page 30, line 3, for females, read female.

Page 33, line 1, for interior, read inferior.

Page 35, line 22, for pronotum, read pronotal spot.

Page 36, strike out lines 26-28.

Page 44, line 20, strike out "and mention is made of two others not fully studied."

Page 45, line 17 from bottom, for sutures, read suture.

Page 48, line 5 from bottom, for when, read where.

Page 54, line 13 from bottom, for 9, read 8.

Page 61, line 16 from bottom, for appears, read appear.

Page 66, line 20, for the second 1881, read 1882.

Page 68, line 12, for in, read of.

Page 72, strike out line 7 from bottom (reference to plate); lines 16 and 17, strike out "prolegs pale brown, blackish at base."

Page 77, line 8 from bottom, strike out report.

Page 82, line 3 from bottom, for more, read less.

Page 83, line 18, for 1-3, read 4-5.

Page 89, line 12 from bottom, for tubucles, read tubercles.

Page 94, line 20 from bottom, after is, insert of.

Page 104, line 11 from bottom, strike out the.

Page 105, line 7, for those, read that; line 10, for probably, read possibly; line 9 from bottom, for *quercitronis*, read *quercitronis*.

Page 106, line 2 from bottom, for this, read these.

Page 108, line 6, for those, read that; line 14 from bottom, before soaps, read common.

Page 109, line 3, for injery, read injury.

Page 110, line 16 from bottom, strike out "that of."

Page 112, line 13 from bottom, for XI, read XII.

Page 114, line 7 from bottom, after part, for of, read or.

Page 117, line 21, after adult, insert of; line 8 from bottom, for *albopita*, read *albopicta*.

APPENDIX

TO THE

FOURTEENTH REPORT.

GENERAL INDEXES

TO THE

FIRST TWELVE REPORTS

OF THE STATE ENTOMOLOGISTS
OF ILLINOIS,

B. D. WALSH, FRANCIS LEBARON, CYRUS THOMAS,
AND S. A. FORBES.

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Systematic list of species.....IX
General index to insects.....I
General index to food plants.....69
General index to remedies, natural and artificial.....95

INTRODUCTION.

The office of State Entomologist of Illinois was established by an act of the Legislature, approved and in force March 9, 1867, by which the Governor was authorized to appoint "by and with the consent of the Senate some competent scientific person as State Entomologist, who shall hold the appointment for two years and until his successor shall be appointed." This officer was required to investigate the entomology of Illinois, and particularly to study "the history of the insects injurious to the products of the horticulturists and agriculturists of the State;" and was directed to "collect and preserve a cabinet of insects to be deposited at the Illinois Industrial University." He was required to "prepare a report of his researches and discoveries in entomology for publication by the State annually;" and his salary was fixed at the sum of $2000 per annum.

The first appointee under this law was Benjamin Dane Walsh, of Rock Island, nominated by Governor Oglesby, June 11, 1867, at an extra session of the Legislature. The Senate, however, declined to act on the Governor's nominations at this special session, adopting, June 13, a resolution postponing such action until the next regular, meeting of the General Assembly, and Mr. Walsh's appointment was therefore not completed.

He nevertheless entered at once on the duties of the office, and prepared a report for the year 1867 as "Acting State Entomologist," which he submitted, not to the Governor, but to the State Horticultural Society. This report was published in 1868 as an appendix to Volume I of the new series of the Transactions of the Society (for 1867), and an unknown number of copies were also issued separately, in pamphlet form, with a slightly different title page.

At the next regular session of the Legislature, an act was passed "for the relief of the State Entomologist" (in force March 15, 1869) which recognized Mr. Walsh's appointment "and the faithful discharge of his full duties from the date of his nomination," directed "that he should receive the compensation provided by the statute under which he was appointed, as full compensation for his services from and after June 11, 1867, and until otherwise provided by law."

On the 12th November, 1869, Mr. Walsh died from the effects of a railway accident, without presenting any other report than that for 1867, already mentioned.

His successor was William LeBaron, of Geneva, Kane Co., appointed April 2, 1870. LeBaron's First Annual Report, the second of the series, counting that of Walsh as the first, was for the year 1870, and was published in August, 1871 as a separate pamphlet, the first edition, printed in February, having been destroyed by fire before publication. I have not been able to as certain that it was published in any other form.

Le Baron's Second Report, number three of the series, covered the year 1871, and was published in 1872 in Vol. III. of the Reports made to the General Assembly at its Twenty-seventh Session, convened January 4, 1871; and also as an appendix to the Transactions of the Illinois Horticultural Society for the year 1871.

His Third Report (the fourth from the office), for the year 1872, was published during the following year in the Reports made to the General Assembly for the session of 18.3. It consisted of two parts, the first devoted to injurious insects simply, and the second, paged separately, consisting of an introduction to general and economic entomology, intended to prepare the way for a series of systematic reports on the several orders of insects.

The Fourth (and last) Report of Dr. Le Baron, cited in the following index as the fifth of the series, consisted of a reprint of Part II, of the preceding Report, followed by a systematic treatise on the order Coleoptera, paged continuously with the foregoing, the whole being issued as the Report for 1873. It was printed in the appendix to the Transactions of the State Horticultural Society for that year, and was also issued separately as an independent volume, copyrighted by the author.

Although Dr. Le Baron continued in office until the expiration of his term, April 9, 1875, no report seems to have been presented for the year 1874. His successor, Cyrus Thomas, was appointed April 13, 1875.

In the meantime the Legislature had, by an act "to change the fiscal year," approved March 29, 1875, and in force July 1 of that year, directed that the reports of a number of State officers, including the State Entomologist, should be rendered to the Governor on or before the first day of November in the year 1876, and biennially thereafter, closing with the fiscal year preceding each regular session of the General Assembly; and had further directed that no other annual or biennial report should be made by any of the officers mentioned. Dr. Thomas's First Report (the Sixth of the State Entomologist) was rendered, in accordance with this law, towards the close of the year 1876, and related to that year and the preceding. It is styled the "Sixth Report of the State Entomologist of Illinois. * * * * First Biennial Report, by Cyrus Thomas, Ph. D., State Entomologist of Illinois." This Report was published in the Transactions of the State Department of Agriculture for 1876 (Vol. 14).

Notwithstanding the direction above cited with respect to the period to be covered by the successive reports of the Entomologist, the Legislature passed, during the session of 1877, an act, approved and in force May 25 of that year, authorizing the State Board of Agriculture to append to and publish with their Annual Report the

Annual Report of the State Entomologist,* and repealing all acts and parts of acts inconsistent with that in which the above authorization is given, so far as the same related to the State Board of Agriculture. This law was interpreted by Dr. Thomas to make it the duty of the State Entomologist to report annually instead of biennially, and his Second Report (the seventh in all) was consequently rendered in 1877, and related to the work of that year. It was printed, as authorized by the above law, as an appendix to the Report of the State Department of Agriculture, and two hundred copies are understood to have been issued separately in pamphlet form.

The succeeding Reports, from the Eighth to the Eleventh, (from the third to the sixth of Thomas), have a similar history, all being annually published as appendices to the Agricultural Report of the corresponding year, and issued separately to the number of two hundred copies. These appendices are all paged separately, and are not mentioned upon the title page of the Report of the Department nor in the lettering upon the back of the volume.

The Eleventh Report (for 1881) was the last by Dr. Thomas, as he tendered his resignation early in 1882, to take effect June 30, of that year.

The present incumbent, Stephen Alfred Forbes, was appointed July 3, 1882, and his first Report, the Twelfth of the office and the last here indexed, although made as for the entire year then current, actually related only to the latter half of it.

To complete the record of the office to the date of writing, it may be added that the Thirteenth and Fourteenth Reports, for the years 1883 and 1884, were printed, like the preceding, as appendices to the Transactions of the State Department of Agriculture for the corresponding years, and that the usual editions of two hundred copies each were issued separately.

No office accommodations have ever been furnished the State Entomologist by the State, and the location of the office has consequently varied with the personal residence of the Entomologist,—that of Mr. Walsh at Rock Island, of Dr. LeBaron at Geneva, of Dr. Thomas at Carbondale, and that of Prof. Forbes, at first at the State Normal University, at Normal, but transferred to the Illinois Industrial University, at Champaign, at the beginning of the current year.

The first legislative appropriation to the State Entomologist for any expenses other than those of salary and the bare publication of his reports, was made at the session of 1873, when $700 was appropriated for the illustration of the reports of Dr. LeBaron for the years 1872 and 1873, and for the necessary stationery and postage stamps to be used in the performance of his official duties. Dr. LeBaron had received, however, previous to this time, from the contingent fund of the Governor, the sum of $2,685,

*This provision was reiterated in 1883, in the amended law relating to the State Board of Agriculture.

$2,500 of which was intended and used for the purchase of the Walsh Collection of Insects, afterwards destroyed in the Chicago fire.

The next special appropriation to the office was made as an item in the appropriation bill for the State Laboratory of Natural History at Normal for the years 1883 and 1884, by which $500 per annum was assigned to the office and incidental expenses of the State Entomologist.

No provision has ever been made for a library for the Entomologist, or for a collection of the insects of the State for his use other than that required by law to be deposited with the State Industrial University.

The incidental association of the office of State Entomologist with that of Director of the State Laboratory of Natural History, brought about by the appointment of the latter officer to the former office in 1882, has, however, given to the State Entomologist command of the resources of the State Laboratory of Natural History, including its entomological collections and library, and has enabled him, since the above date, to draw upon the corps of assistants of this establishment for a large amount of important service.

The scope and variety of the fourteen reports of this office are sufficiently indicated by the voluminous lists and indexes necessary to give convenient access to their contents. In volume they far exceed the literature of the economic entomology of any other State, amounting in all to 2,258 pages, of which 104 have been contributed by Walsh, 419 by LeBaron, 1,187 by Thomas, and 648 by Forbes. They may broadly be said to contain four classes of matter,—(1) original contributions to entomology, chiefly prepared with reference to economic applications, characteristic especially of the first four and the last three reports; (2) treatises on the classification of single orders of insects, as in the 5th and 6th Reports (Coleoptera), the 7th and 10th (Lepidoptera), the 8th (Homoptera especially Aphides), and the 9th (Orthoptera); (3) full summaries of existing knowledge respecting the most important injurious insects, as the Hessian fly and the army worm; and (4) monographs of all the insect enemies of a single crop, as of the insects affecting the strawberry, in the 13th report.

Probably no one conversant with the facts can doubt that the State Entomologists of Illinois have devoted themselves faithfully and with distinguished success (far, in fact, beyond their rather meager opportunities) to the "investigation of the Entomology of Illinois, and particularly to the history of the insects injurious to the products of the agriculturists and the horticulturists of the State."

CHAMPAIGN, ILL., June 30, 1885.

SYSTEMATIC LIST OF GENERA AND SPECIES.*

ARTHROPODA.

INSECTA.

(iv, 203; vi, 65, appendix.)

HYMENOPTERA.

(iv, 25; v, 25; vi, 71; x, 63.)

SCOLIADÆ.

Tiphia inornata, Say, vi, 100.

ICHNEUMONIDÆ.

Ichneumon suturalis, Say, x, 41.
Pezomachus minimus, Walsh, x, 40.
Ophion purgatus, Say, x, 41.
Paniscus geminatus, Say, vii, 218.
Mesochorus vitreus, Walsh, x, 39.
Pimpla conquisitor, Say, vii, 119.

BRACONIDÆ.

Microdes carinodes, Cres., xi, 18.
Microgaster glomeratus, Linn., ix, 29.
  militaris, Walsh, x, 38.
Aphidius avenaphis, Fitch, viii, 176.
  lactucaphis, Fitch, viii, 175.
  polygonaphis, Fitch, viii, 175.
  viburnaphis, Fitch, viii, 175.
Trioxys cerasaphis, Fitch, viii, 176.
  populaphis, Fitch, viii, 176.
  salicaphis, Fitch, viii, 176.
Toxares triticaphis, Fitch, viii, 176.

PROCTOTRUPIDÆ.

Platygaster lecanii, Smith, vii, 129.

CHALCIDIDÆ.

Chalcis albifrons, Walsh, x, 40.
Haltichella perpulchra, Walsh, x, 39 (Hockeria perpulchra).
Eupelmus allyni, French, xi, 73 (Isosoma allynii).
Aphelinus mytilaspidis, LeB., ii, 34.
Glyphe viridescens, Walsh, x, 39.
Pteromalus gelechiæ, Webster, xii, 151.

TENTHREDINIDÆ.

(x, 63.)

Cimbex americana, Leach, var. laportei, Lepel. x, 65 (C. laportei).
Abia caprifolium, Norton, x, 66.
  cerasi, Fitch, x, 66.
Pristiphora identidem, Norton, x, 69.
  grossulariæ, Walsh, x, 69.
  rufipes, St. Farg., x, 70.
Emura orbitalis, Norton, x, 69.
  salicis-ovum, Walsh, x, 69.
  salicis-gemma, Walsh, x, 69.
  salicicola, Smith, x, 69.
Nematus ventricosus, Klug, x, 68; xi, 46.
  ventralis, Say, x, 68.
  salicis-pisum, Walsh, x, 68.
  trilineatus, Norton, x, 68.
  salicis-pomum, Walsh, x, 68.
Emphytus maculatus, Norton, vii, 111; x, 68.
Dolerus arvensis, Say, x, 67.
Selandria rubi, Harr., vi, 61; x, 67.
  tiliæ, Norton, x, 67.
  cerasi, Peck, x, 67; xii, 98.
  roseæ, Harr., ii, 79; x, 66.
  caryæ, Norton, x, 66.
  juglandis, Fitch, x, 67.
Lophyrus abbotti, Leach, x, 70.

UROCERIDÆ.

(x, 70.)

Urocerus albicornis, Fabr., x, 71.
  abdominalis, Harr., x, 71.
Tremex columba, Linn., vi, 41; x, 71.

*The names used in the following list, are those now current. Where these differ from those used in the reports, the latter have been repeated in parenthesis, *after* the page references.

LEPIDOPTERA.

(iv, 25; v, 25; vi, 71; vii, 269; x, 72, 145.)

Rhopaloceres.

(vii, 269.)

PAPILIONIDÆ.

(vii, 135, 269; x, 73.)

Papilio ajax, Linn., vii, 135; x, 74.
  philenor, Linn., v i, 136; x, 73, 164.
  asterias, Fabr., vii, 137; x, 74, 173.
  troilus, Linn., vii, 138; x, 74.
  turnus, Linn., vii, 139; x, 74, 173.
  cresphontes, Cram., vii, 139; x, 75.
Pierinæ, x, 76.
Pieris monuste, Linn., ix, 32.
  beckeri, Edw., ix, 28; 33 (P. protodice, var. beckerii).
  sisymbrii, Bd., ix, 28, 34.
  occidentalis, Reak., ix, 28, 34; ix, 29 (P. calyce).
  protodice, Bd.-Le C., vii, 141; ix, 25, 28, 33; x, 76, 173.
  napi, Esper, vii, 143 (P. oleracea); ix, 28, 34; ix, 26 28, 29 (P. oleracea); ix, 28 (P. frigida); ix, 28, 32 (P. venosa); x, 77 (P. oleracea).
  virginiensis, Edw., ix, 29.
  rapæ, Linn., vii, 144; ix, 8, 31; ix, 29 (P. yreka); ix, 29 (P. rapæ, var. novangliæ); ix, 32 (P. venosa, var. marginalis); x, 77, 179; xi, 32; xii, 92.
  brassicæ, Linn., ix, 35.
Callidryas eubule, Linn., vii, 147; x, 78.
Colias cæsonia, Stoll, x, 78.
  eurytheme, Bd., vii, 147; x, 78.
  philodice, Godt., vii, 147; x, 78.
Terias nicippe, Cram., vii, 148; x, 79.
  lisa, Bd.-LeC., vii, 148; x, 79.

NYMPHALIDÆ.

(vii, 148, 269.)

Danais archippus, Fabr., vii, 149; x, 79, 161.
Nymphalinæ, x, 80.
Agraulis vanillæ, Linn., x, 80.
Argynnis idalia, Dr., vii, 149; x, 81, 162.
  diana, Cram., vii, 149; x, 81.
  cybele, Fabr., vii, 150; x, 81.
  aphrodite, Fabr., vii, 150; x, 81.
  alcestis, Edw., vii, 150; x, 82.
  atlantis, Edw., x, 82.
  egleis, Bd., x, 164.
  myrina, Cram., x, 82, 161.
  bellona, Fabr., x, 83, 183.
Euptoieta claudia, Cram., vii, 150; x, 80.
Melitæa phæton, Dr., x, 83.
  baroni, H. Edw., x, 163.
Phyciodes nycteis, Doubl.-Hew., x, 83 (Melitæa nycteis); x, 162 (P. harrisii); x, 165.
  tharos, Dr., vii, 151; x, 83 (Melitæa tharos); x, 163.
Eresia texana, Edw., x, 164.
Grapta interrogationis, Fabr., vii, 151; x, 84, 164.
  comma, Harr., vii, 152; x, 84, 163.
  fusnus, Edw., vii, 152; x, 84.
  gracilis, Gr., vii, 152.
  progne, Cram., ii, 59 (Vanessa progne); x, 85.
  j-album, Bd.-LeC., x, 85.
Vanessa antiopa, Linn., vii, 153; x, 85, 163.
  milberti, Godt., x, 85 (Grapta milberti); x, 164.
Pyrameis atalanta, Linn., vii, 153; x, 86.
  huntera, Dr., vii, 154; x, 86, 153.
  cardui, Linn., vii, 154; x, 87, 153.
Junonia cœnia, Hub., vii, 154 (J. lavinia); x, 87 (J. lavinia).
Limenitis ursula, Fabr., vii, 154; x, 87, 162.
  arthemis, Dr., x, 88.
  disippus, Godt., vii, 154; x, 88, 162.
Apatura celtis, Bd.-LeC., vii, 155; x, 88.
  clyton, Bd.-LeC., vii, 155; x, 89.
Paphia troglodyta, Fabr., vii, 156 (P. andria); x, 89 (P. glycerium).
Debis portlandia, Fabr., x, 92.
Neonympha canthus, Bd.-LeC., x, 91.
  gemma, Hub., x, 91.
  eurytris, Fabr., vii, 156; x, 90, 184.
  sosybius, Fabr., x, 91.
Satyrinæ, x, 90 (Libythea wrongly included.)
Satyrus alope, Fabr., vii, 156; vii, 156 (S. nephele); x, 92; x, 92, 180 (S. nephele).
Libythea bachmanni, Kirtl., vii, 157; x, 90.
Thecla m-album, Bd.-LeC., x, 92.
  humuli, How., vii, 157; x, 92.
  acadica, Edw., x, 93.
  calanus, Hub., x, 93.
  strigosa, How., vii, 157; x, 92.
  smilacis, Bd.-LeC., x, 93.
  pœas, Hub., x, 93.
  irus, Godt., x, 94.
  niphon, Hub., x, 94.
  titus, Fabr., x, 94.
Chrysophonus thoe, Bd.-LeC., vii, 158; x, 95.
  hypophyleas, Bd., vii, 158 (C. americana); x, 95 (C. americana.)

LYCÆNIDÆ.

(vii, 157, 270.)

Lycæna scudderi, Edw., x, 95.
  pseudargiolus, Bd.-LeC., vii, 158; x, 95; x, 96 (L. neglecta).
  comyntas, Godt., vii, 158; x, 95.

HESPERIDÆ.

(vii, 159, 270.)

Ancyloxypha numitor, Fabr., x, 96.
Pamphila zabulon, Bd.-LeC., x, 197 (Atrytone hobomok.)
  sassacus, Scudd., vii, 159; x, 97.
  huron, Edw., vii, 159.

Pamphila phylæus, Dr., x. 96, 176.
otho, Sm.-Abb., vii, 160.
peckius, Kirby, vii, 160; x, 178.
mystic, Scudd., x, 97.
cernes, Bd.-LeC., vii, 160.
manataaqua, Scudd., vii, 160.
metacomet, Harr., vii, 161.
maculata, Edw., x, 176.
palatka, Edw., x, 153.
delaware, Edw., x, 96, 174.
Amblyscirtes vialis, Edw., vii, 161.
Pyrgus tessellata, Scudd., vii, 161.
Nisoniades lucilius, Lintn., vii, 161 (Thanaos lucilius); x, 97.
juvenalis, Fabr., vii, 162 (Thanaos juvenalis); x, 97.
Pholisora catullus, Fabr., vii, 162; x, 98.
Eudamus pylades, Scudd., x, 98 (E. bathyllus.)
bathyllus, Sm.-Abb., vii, 162.
lycidas, Sm.-Abb., vii, 162.
tityrus, Fabr., vii, 163; x, 98, 153.
proteus, Linn., x, 184.

Heteroceres.

(vii, 269.)

SPHINGIDÆ.

(vii, 163, 270; x, 99.)

Hemaris tenuis, Gr., x. 159 (Sesia tenuis).
diffinis, Boisd., vii, 163 (Sesia diffinis); x, 99, 160, (S. diffinis).
thysbe, Fab., vii, 164 (Sesia thysbe); x, 98 (S. thysbe).
Thyreus abboti, Swains., vii, 164; x, 100.
Deilephila chamænerii, Harr., x, 159.
lineata, Fabr., vii, 164; x, 100, 159.
Philampelus pandorus, Hubn., vii, 165; x, 101, 175.
achemon, Dr., vii, 165; x, 101, 182.
Chœrocampa tersa, Linn., x, 159.
Everyx myron, Cram., vii, 166 (Darapsa myron); x, 103 (Chœrocampa pampinatrix).
Ampelophaga versicolor, Harr., x, 158 (Darapsa versicolor).
Paonias excæcatus, Abb.-Sm., vii, 167 (Smerinthus excæcatus).
Triptogon modesta, Harr., x. 159 (Smerinthus modestus).
Cressonia juglandis, Sm.-Abb., vii, 167 (Smerinthus juglandis.)
Ceratomia amyntor, Hub., vii 167; x, 102.
Daremma undulosa, Walk., x, 102 (D. Brontes) 159
catalpæ, Boisd., x, 104 (Sphinx catalpæ.)
Diludia jasminearum, Bd-L. C., x, 103.
Phlegethontius carolina, Linn., vii, 168, (Macrosila Carolina); x, 103, 158.
celeus, Hubn., vii, 169 (Macrosila 5-maculata); x, 104 (M. 5 maculata.)
cingulata, Fabr., x, 104, 158, (Macrosila cingulata.)
Sphinx drupiferarum, Abb.-Sm., x, 104.
Kalmiæ, Abb.-Sm., x, 104.
chersis, Hubn., x, 105.
gordius, Cram., x, 105 (Lethia gordius.)
Ellema coniferarum, Abb.-Sm., x, 105. (Sphinx coniferarum.)
bombycoides, Walk., x, 105 (Sphinx harrisii.)
pineum, Lintn., x. 105 (Sphinx pineum.)

ÆGERIDÆ.

(vii, 169, 270; x, 106.)

Melittia ceto, Westw., vi, 41 (Ægeria cucurbitæ); vii, 173 (Æ. cucurbitæ); x, 107 (Æ. cucurbitæ.)
Alcathoe caudatum, Harris, vii, 172 (Ægeria caudata); x, 108 (Æ. caudata.)
Bembecia marginata, Harr., vi, 40 (Ægeria rubi); vii, 175 (Æ. rubi); x, 108 (Æ. rubi.)
Sciapteron polistiformis, Harr., i. 24 (Ægeria polistiformis); vii, 171 (Æ. polistiformis); x, 108 (Æ. polistiformis.)
anthracipennis, Boisd., x, 109 (Ægeria anthracipennis.)
Fatua denudata, Harr., x. 109 (Ægeria asilipennis.)
Podosesia syringæ, Harr., vii, 174 (Ægeria syringæ); x. 109 (Æ. syringæ.)
Sannina exitiosa, Say, vi, 38 (Ægeria exitiosa); vii, 169; (Æ. exitiosa); x, 107 (Æ. exitiosa).
Ægeria pictipes, G. & R., x. 109.
pyri, Harr., vi, 40; vii, 170; x, 107.
acerni, Clem., vi, 40; vii, 173; x, 108.
tipuliformis, Linn., vi, 39; vii, 172; x, 107, 151.
tiliæ, Harr., x, 109.

ZYGÆNIDÆ.

(vii, 176, 270; x, 110.)

Alypia octomaculata, Fabr., vii, 176; x, 110, 172.
Psychomorpha epimenis, Dr., vii, 177; x, 111, 172.
Endryas unio, Hubn., vii 178; x, 111, 173.
grata, Fabr., vii, 179; x, 111, 173.
Scepsis fulvicollis, Hubn., vii, 179 (Ctenucha fulvicollis); x, 171.
Ctenucha virginica, Chap., x, 170.
Acoloithus falsarius, Clem., x, 112.
Harrisina americana, Harr., vii, 179 (Acoloithus americana); x, 112 (A. americana.)

BOMBYCIDÆ.

(vii, 179, 271; x, 113.)

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    occidentalis.
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    malifoliæ, Apple-leaf Aphis.
  Aspidiotus harrisi, Harris' Bark-louse.
  Attacus cecropia, Cecropia Silkworm.
  Bostrichus basilaris, Shag-bark Hickory-tree Borer.
  Carpocapsa pomonella, Codling Moth.
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  Chrysobothris femorata, Flat-headed Apple-tree Borer.
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  Conotrachelus nenuphar, Plum Curculio.
  Datana ministra, Yellow-necked Apple-tree Caterpillar.
  Deilephila lineata, White-lined Sphinx.
  Diabrotica longicornis, Corn Root-worm.
  Eccopsis malana, Apple-bud Worm.
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    villosum, Oak Twig-pruner.
  Epicærus imbricatus, Imbricated Snout-beetle.
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  Haltica helxines, Small Bronze Flea-beetle.
  Hibernia tiliaria, Yellow Canker-worm.
  Hispides.
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*The names under each plant name are those of the insects feeding upon the plant; and all references in the text to these insects, may be found in the preceding insect index.

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Lachnosterna fraterna, Kindred May-beetle.
fusca, Dark May-beetle.
pilosicollis, Hairy May-beetle.
Lachnus dentatus, Spotted Willow-aphis.
Lathia gordius.
Limenitis disippus, Disippus Butterfly.
Lithophane cinerea, Ash-gray pinion.
Loxotænia rosaceana, Greater Leaf-roller.
Lucanus dama, Pinching-beetle.
Macrodactylus subspinosus, Rose bug.
Melolonthidæ, White Grubs.
Mytilaspis conchiformis, Oyster-shell Bark-louse.
Œdemasia concinna, Red-humped Prominent.
Orgyia leucostigma, White-marked Tussock Moth.
Papilio turnus, Turnus Butterfly.
Parorgyia parallela.
Pempelia hammondi, Apple-leaf Skeletonizer.
Phigalia cinctaria.
Phoxopteris nubeculana.
Phycita nebulo, Apple Leaf-crumpler.
Prionus laticollis, Broad-necked Prionus.
Saperda candida, Round-headed Apple-tree Borer.
Saturnia maia, Buck Moth.
Schizoneura lanigera, Woolly Aphis of the Apple-tree.
Sciara mali, Apple Midge.
Smerinthus excæcatus, Blind-eyed Sphinx.
Telea polyphemus, Polyphemus Silk-worm.
Tolype velleda, Lappet Moth.
Tortrix cinderella, Green Apple Leaf-tyer.
malivorana, Lesser Apple-leaf Folder.
Tremex columba, Elm-tree Borer.
Trypeta pomonella, Apple Maggot-fly.
Xyleutes robiniæ, Locust-tree Carpenter Moth.
Apple of Peru. (See Thorn Apple.)
Apricot.
Ægeria exitiosa, Peach-borer.
Conotrachelus nenuphar, Plum Curculio.
Arbor vitæ.
Callosamia promethea, Prometheus Silkworm.
Phytoptus thujæ.
Archangel, Archangelica.
Plusia iota.
Aristolochia serpentaria. (See Virginia Snakeroot.)
A. sipho. (See Dutchman's Pipe.)
A. tomentosa.
Papilio philenor, Philenor Swallow-tail.
Ash.
Callosamia promethea, Prometheus Silkworm.
Clisiocampa sylvatica, Tent Caterpillar of the Forest.
Daremma brontes.
Diludia jasminearum.
Halesidota caryæ.
Hyperchiria io, Io Moth.
Hyphantria textor, Fall Web-worm.
Neoclytus capræ, Ash-tree Borer.
Pemphigus fraxinifolii.
Xyloryctes satyrus.
Ash, Black or Water.
Pemphigus fraxinifolii.
Ash, Blue.
Pemphigus fraxinifolii.
Ash, Green.
Phytoptus fraxini.
Ash, White or American.
Pemphigus fraxinifolii.
Phytoptus, sp.
Asparagus.
Ceramica picta, Zebra Caterpillar.
Crioceris asparagi, Asparagus Beetle.
Elateridæ, Wire worms.
Aspen.
Limenitis arthemis.
Aspen, American, Populus tremuloides.
Cossus centerensis.
Pemphigus populicaulis, Poplar-leaf Gall-louse.
Aspen, Large-toothed, Populus grandidentata.
Aphis populifoliæ, Poplar-leaf Aphis.
Aster.
Aphis middletoni.
Ceramica picta, Zebra Caterpillar.
Gortyna nitela, Stalk Borer.
Phyciodes harrisi.
nycteis.
tharos, Tharos Butterfly.
Saturnia maia, Buck Moth.
Aster, Double-bristled. Diplopappus umbellatus.
Phyciodes harrisi.
Aster, Wild.
Leucania unipuncta, Army worm.
Azalea.
Callosamia promethea, Prometheus Silk-worm.

B

Balm of Gilead.
Ægeria tiliæ.
Chaitophorus candicans, Balm of Gilead Plant-louse.
Hyperchiria io, Io Moth.
Prionus laticollis, Broad-necked Prionus.

Balm of Gilead.
Xyleutes robiniæ, Locust-tree Carpenter Moth.
Balsam.
Hyperchiria io, Io Moth.
Barberry.
Attacus cecropia, Cecropia Silkworm.
Callosamia promethea, Prometheus Silkworm.
Rhopalosiphum berberidis.
Barley.
Agrotis saucia, Variegated Cutworm.
Blissus leucopterus, Chinch bug.
Cecidomyia destructor, Hessian fly.
Elateridæ, Wire worms.
Gelechia cerealella, Angoumois Grain Moth.
Siphonophora avenæ, Grain Plant-louse.
Basswood, Lime-tree, American Linden.
Datana ministra, Yellow-necked Apple-tree Caterpillar.
Grapta interrogationis, Semicolon Butterfly.
Hibernia tiliaria, Yellow Canker-worm.
Limenitis arthemis.
Phytoptus abnormis.
Telea polyphemus, Polyphemus Silkworm.
Bayberry, Myrica.
Callosamia promethea, Promethus Silkworm.
Bean.
Agrotis clandestina, W-marked Cutworm.
Aphis rumicis, Bean Aphis.
Bruchus granarius, Grain Bruchus.
obsoletus, Bean Weevil.
Ceramica picta, Zebra Caterpillar.
Diabrotica longicornis, Corn Root-worm.
Elateridæ, Wire-worms.
Heliothis armigera, Corn worm.
Macrobasis unicolor, Ash-gray Blister-beetle.
Spilosoma virginica, Yellow Bear.
Thecla humuli, Hop-vine Thecla.
Bean, Wild, Phaseolus perennis.
Eudamus proteus.
Lycæna comyntas, Comyntas Butterfly.
Bedstraw, Galium aparine.
Aphis rumicis, Bean Aphis.
Bedstraw, Galium circæzans.
Aphis circæzandis.
Beech.
Actias luna, Luna Silkworm.
Chrysobothris femorata, Flat-headed Apple-tree Borer.
Dicerca divaricata, Cherry-tree Borer.
Phyllaphis fagi, Beech Aphis.
Schizoneura fagi, Beech Blight.
imbricator, Beech-tree Blight.
Beet.
Elateridæ, Wire worms.
Beet.
Ceramica picta, Zebra Caterpillar.
Silpha opaca.
Spilosoma virginica, Yellow Bear.
Bidens chrysanthemoides. (See Bur-marigold.)
Bilberry.
Thecla irus.
Birch.
Actias luna, Luna Silkworm.
Callipterus betulæ.
betulæcolens.
Callosamia promethea, Prometheus Silkworm.
Datana ministra, Yellow-necked Apple-tree Caterpillar.
Hyperchiria io, Io Moth.
Hyphantria textor, Fall Web-worm.
Telea polyphemus, Polyphemus Silkworm.
Birthwort. (See Aristolochia tomentosa.)
Bitter-sweet.
Doryphora 10-lineata, Colorado Potato-beetle.
Blackberry.
Ægeria rubi, Raspberry Root-borer.
Agrilus ruficollis, Raspberry Cane Borer.
Anomala binotata, Two-spotted Vine-chafer.
Psylla rubi, Blackberry Flea-louse.
Serica vespertina, Evening Silky Leaf-chafer.
Sipha rubifolii.
Siphonophora rubi.
Blackberry, Wild.
Loxotænia rosaceana, Greater Leaf-roller
Black Snakeroot, Cimicifuga racemosa.
Lycæna pseudargiolus, Azure-blue Butterfly.
Blueberry.
Telea polyphemus, Polyphemus Silkworm.
Thecla irus.
Box-elder. (See Maple, Ash-leaved.)
Box-thorn.
Doryphora 10-lineata, Colorado Potato-beetle.
Brassica.
Pieris virginiensis.
Brassica napus.
Pieris napi.
Broccoli.
Pieris virginiensis.
Broom, Sarothamnus scoparius.
Siphonophora menthæ.
rubi.
Broom-corn.
Blissus leucopterus, Chinch bug.
Buckeye.
Orgyia leucostigma, White-marked Tussock Moth.

Buckwheat.
Agrotis clandestina, W-marked Cutworm.
Caloptenus spretus, Rocky Mountain Locust.
Deilephila lineata, White-lined Sphinx.
Gastrophysa polygoni.
Bulrush, Typha latifolia.
Plusia festucæ.
Burdock.
Ceramica picta, Zebra Caterpillar.
Loxotænia rosaceana, Greater Leaf-roller.
Plusia chrysites.
iota.
precationis, Thistle Plusia.
simplex, Celery worm.
Pyrameis cardui, Thistle Butterfly.
huntera, Hunter's Butterfly.
Pyrrharctia isabella, Hedgehog Caterpillar.
Bur-marigold, Bidens chrysanthemoides.
Siphonophora rudbeckiæ.
Burning bush, Euonymus atropurpureus.
Aphis rumicis, Bean Aphis.
Bush Clover, Lespedeza.
Hyperchiria io, Io Moth.
Lycæna comyntas, Comyntas Butterfly.
Butterfly Pea, Clitoria mariana.
Eudamus proteus.
Butternut, White Walnut.
Citheronia regalis, Royal Walnut Moth.
Hyphantria textor, Fall Web-worm.
Selandria juglandis.
Spilosoma virginica, Yellow Bear.
Telea polyphemus, Polyphemus Silkworm.
Button-bush, Cephalanthus.
Aphis cephalanthi, Button-bush Aphis.

C

Cabbage.
Agrotis annexa, Cabbage Cutworm.
clandestina, W-marked Cutworm.
c-nigrum, Spotted Cutworm.
messoria, Dark-sided Cutworm.
saucia, Variegated Cutworm.
Aphis brassicæ, Cabbage Plant-louse.
Caloptenus spretus, Rocky Mountain Locust.
Ceramica picta, Zebra Caterpillar.
Elateridæ, Wire worms.
Hadena devastatrix, Glassy Cutworm.
Ludius brevicornis, Wire worm.
Mamestra subjuncta, Speckled Cutworm.
Murgantia histrionica, Harlequin Cabbage bug.
Orchestris vittata, Striped Flea-beetle.
Orobena rimosalis, Cabbage Pionea.
Pieris brassicæ.
napi.
oleracea, Turnip Butterfly.
Cabbage.
Pieris protodice, Southern Cabbage Butterfly.
rapæ, European Cabbage worm.
virginiensis.
Pionea forficalis, Cabbage-garden Pebble Moth.
stramentalis, Black-headed Cabbage worm.
Plusia brassicæ, Cabbage Plusia.
Plutella cruciferarum, European Cabbage Web Moth.
Spilosoma virginica, Yellow Bear.
Canada Thistle. (See Thistle, Canada.)
Capsicum.
Sitodrepa panicea.
Caraway.
Papilio asterias, Asterias Butterfly.
Carnation.
Elateridæ, Wire worms.
Rhopalosiphum dianthi.
Carrot.
Elateridæ, Wire worms.
Papilio asterias, Asterias Butterfly.
Cassia.
Callidryas eubule, Danewort Butterfly.
Terias nicippe, Nicippus Butterfly.
Castor-oil Plant, Castor Bean.
Gortyna nitela, Stalk Borer.
Catalpa.
Sphinx catalpæ.
Cauliflower.
Ceramica picta, Zebra Caterpillar.
Pieris rapæ, European Cabbage-worm.
virginiensis.
Cedar.
Thyridopteryx ephemeræformis, Bagworm.
Cedar, Red.
Hylurgus dentatus, Toothed Hylurgus.
Thecla smilacis.
Celery.
Papilio asterias, Asterias Butterfly.
Plusia simplex, Celery worm.
Cephalanthus.
Callosamia promethea, Prometheus Silkworm.
Checkerberry.
Cœlodasys unicornis, Unicorn Apple-tree Caterpillar.
Chenopodium. (See Pigweed.)
Cherry.
Ægeria exitiosa, Peach Borer.
Agrotis saucia, Variegated Cutworm.
Anisopteryx autumnata, Fall Canker-worm.
vernata, Spring Canker-worm.
Apatela occidentalis.
Aphis cerasifoliæ, Cherry-leaf Plant-louse.
Attacus cecropia, Cecropia Silkworm.
Chrysobothris femorata, Flat-headed Apple-tree Borer.
Clisiocampa americana, Apple-tree Tent Caterpillar.

clisiocampa sylvatica, Tent Caterpillar of the Forest.
Conotrachelus nenuphar, Plum Curculio.
Datana ministra, Yellow-necked Apple-tree Caterpillar.
Dicerca divaricata, Cherry-tree Borer.
Epicærus imbricatus, Imbricated Snout-beetle.
Hyphantria textor, Fall Web-worm.
Ithycerus noveboracensis, New York Weevil.
Lachnosterna fraterna, Kindred May-beetle.
fusca, Dark May-beetle.
pilosicollis, Hairy May-beetle.
Limenitis ursula, Ursula Butterfly.
Loxotænia rosaceana, Greater Leaf-roller.
Macrodactylus subspinosus, Rosebug.
Myzus cerasi, Cherry-tree Aphis.
Œdemasia concinna, Red-humped Prominent.
Papilio turnus, Turnus Butterfly.
Phycita nebulo, Apple Leaf-crumpler.
Selandria cerasi, Cherry Slug.
Tortrix fervidana.
Cherry, Black.
Clisiocampa americana, Apple-tree Tent Caterpillar.
Hyphantria textor, Fall Web-worm.
Cherry, Wild.
Attacus cecropia, Cecropia Silkworm.
Callosamia promethea, Prometheus Silkworm.
Papilio turnus, Turnus Butterfly.
Thecla titus.
Cherry, Wild Black.
Abia cerasi, Cherry Abia.
Hyphantria textor, Fall Web-worm.
Hyperchiria io, Io Moth.
Lycæna comyntas, Comyntas Butterfly.
Chestnut.
Apatela americana, American Maple Moth.
hamamelis.
Callipterus castaneæ, Chestnut Gay-Louse.
Choke Cherry.
Aphis cerasifoliæ, Cherry-leaf Plant-louse.
Attacus cecropia, Cecropia Silkworm.
Hyperchiria io, Io Moth.
Telea polyphemus, Polyphemus Silk-worm.
Tortrix fervidana.
Cimicifuga racemosa. (See Black Snake-root.)
Cineraria, Senecio cineraria.
Pyrameis cardui, Thistle Butterfly.
huntera, Hunter's Butterfly.
Citrus.
Papilio cresphontes, Cresphontes Butterfly.
Cladosporium.
Diabrotica longicornis, Corn Root-worm.
Clover.
Callidryas eubule, Danewort Butterfly.
Caloptenus femur-rubrum, Red-legged Locust.
Cecidomyia leguminicola.
Ceramica picta, Zebra Caterpillar.
Colaspis brunnea.
Colias cæsonia.
eurytheme, Eurytheme Butterfly.
philodice, Philodice Butterfly.
Cutworms.
Diabrotica longicornis, Corn Root-worm.
Drasteria erechtea, Clover Drasteria.
Elateridæ, Wire worms.
Hypena scabra.
Hyperchiria io, Io Moth.
Hyphantria textor, Fall Web-worm.
Leucania unipuncta, Army-worm Moth.
Lycæna comyntas, Comyntas Butterfly.
Pyralis farinalis, Meal Snout Moth.
Pyrrharctia isabella, Hedge-hog Caterpillar.
Terias lisa, Lisa Butterfly.
nicippe, Nicippus Butterfly.
Clover, Red.
Diabrotica 12-punctata.
Epicærus imbricatus, Imbricated Snout-beetle.
Clover hay.
Asopia costalis, Clover-hay worm.
Pyralis farinalis, Meal Snout Moth.
Columbine, Aquilegia canadensis.
Nisoniades lucilius.
Columbine, Aquilegia.
Hyalopterus aquilegiæ.
Composite Family, Compositæ.
Coccinellidæ, Lady-bugs.
Diabrotica longicornis, Corn Root-worm.
Harpalus.
Megilla maculata, Spotted Lady-bug.
Cone-flower, Rudbeckia laciniata.
Siphonophora rudbeckiæ.
Convolvulus.
Spilosoma virginica, Yellow Bear.
Convolvulus Family, Convolvulaceæ.
Cassida bivittata, Two-striped Tortoise-beetle.
nigripes, Black-legged Tortoise-beetle.
Cassidinæ, Tortoise Beetles.
Coptocycla aurichalcea, Golden Tortoise-beetle.
guttata, Mottled Tortoise-beetle.
Coreopsis.
Acmæodera pulchella.
tubulus.
Coreopsis aristosa.
Siphonophora coreopsidis, Aphis of the Spanish Needle.

Corn.
Achatodes zeæ, Spindle worm.
Agrotis ypsilon, Greasy Cutworm.
Apatela oblinita, Smeared Dagger.
Aphidæ, Plant-lice.
Aphis maidis, Corn Plant-louse.
Arctia arge, Arge Tiger Moth.
phalerata, Harnessed Moth.
Blissus leucopterus, Chinch bug.
Caloptenus femur-rubrum, Red-legged Locust.
spretus, Rocky Mountain Locust.
Ceramica picta, Zebra Caterpillar.
Diabrotica 12-punctata.
longicornis, Corn Root-worm.
Elateridæ, Wire worms.
Empretia stimulea, Saddle-back Moth.
Epicauta pennsylvanica.
vittata, Striped Potato-beetle.
Gelechia cerealella, Angoumois Grain Moth.
Gortyna nitela, Stalk Borer.
zeæ.
Hadena arctica, Yellow-headed Cutworm.
devastatrix, Glassy Cutworm.
Heliothis armigera, Corn worm.
Hyperchiria io, Io Moth.
Iulus impressus, Corn Myriapod.
Lachnosterna fraterna, White Grub or Kindred May-beetle.
fusca, White Grub or Dark May-beetle.
pilosicollis, White Grub or Hairy May-beetle.
Laphygma frugiperda, Fall Army-worm.
Leucania unipuncta, Army-worm.
Leucarctia acræa, Salt-marsh Caterpillar.
Lygus lineolaris, Tarnished Plant-bug.
Macrodactylus subspinosus, Rose bug.
Melolonthidæ, White Grubs.
Nephelodes violans, Smooth Cutworm.
Omophron.
Prodenia commelinæ, Corn Cutworm.
Pyralis farinalis, Meal Snout Moth.
Sipha maydis, Corn Sipha.
Sphenophorus zeæ, Corn Curculio,
Spilosoma virginica, Yellow Bear.
Zabrus.

Corn, Sweet.
Blissus leucopterus, Chinch bug.
Euryomia inda, Indian Cetonian.
Heliothis armigera, Corn worm.
Spilosoma virginica, Yellow Bear.

Cornel, Panicled. Cornus paniculata.
Aphis cornifoliæ.

Cotton.
Aletia argillacea, Cotton worm.
Heliothis armigera, Boll worm.
Hyperchiria io, Io Moth.
Tetranychus, Red Spider.
Thecla pœas.

Cottonwood.
Ægeria asilipennis.
Apatela americana, American Maple Moth.
lepusculina, Cotton-wood Dagger.
Argyrolepia quercifoliana, Oak-leaf Tortrix.
Chaitophorus populicola.
Pemphigus populicaulis, Poplar-leaf Gall-louse.
populi-transversus.
pseudobyrsa.
vagabundus, Vagabond Gall-louse.

Cotton-wood, Narrow-leaved, Populus balsamifera, var. angustifolia.
Pemphigus populi-monilis.

Crab-apple.
Aspidiotus harrisi, Harris's Bark-louse.
Carpocapsa pomonella, Codling Moth.
Hyphantria textor, Fall Web-worm.
Loxotænia rosaceana, Greater Leaf-roller.
Parorgyia parallela.
Phycita nebulo, Apple Leaf-crumpler.
Xyleutes robiniæ, Locust-tree Carpenter Moth.

Crab-apple, Siberian.
Carpocapsa pomonella, Codling Moth.
Limenitis ursula, Ursula Butterfly.
Loxotænia rosaceana, Greater Leaf-roller.

Crab-apple, Transcendent.
Eccopsis malana, Apple-bud worm.

Crab-apple, Wild.
Anthonomus 4-gibbus, Apple Curculio.

Cranberry.
Pristiphora identidem.
Thecla irus.

Cranberry-tree, Viburnum opulus.
Aphis viburni, Snowball Aphis.

Croton capitatum.
Paphia andria, Goatweed Butterfly.
glycerium.

Cruciferæ.
Flea beetles.
Orchestris vittata, Striped Flea-beetle.

Cucumber.
Aphis cucumeris, Melon plant-louse.
Diabrotica 12-punctata.
longicornis, Corn Root-worm.
vittata, Striped Cucumber-beetle.
Epitrix cucumeris, Cucumber Flea-beetle.
Melittia cucurbitæ, Squash Borer.
Phacellura nitidalis, Pickle-worm.
Polydesmus complanatus, Flattened Centipede.
Psylliodes punctulata, Punctulated Flea-beetle.

Cucumber, Wild.
Aphis, Plant-louse.

Cucurbitaceæ. (See Gourd family.)

Cud-weed, Gnaphalium.
Pyrameis huntera, Hunter's Butterfly.

Cup-plant, Silphium integrifolium.
Siphonophora rudbeckiæ.
Currant.
Ægeria tipuliformis, Currant Borer.
Agrotis clandestina, W-marked Cutworm.
Angerona crocataria.
Attacus cecropia, Cecropia Silkworm.
Caloptenus femur-rubrum, Red-legged Locust.
Capsus quadrivittatus, Four-striped Plant-bug.
Cutworms.
Doryphora 10-lineata, Colorado Potato-beetle.
Eufitchia ribearia, Gooseberry Spanworm.
Eupithecia interrupto-fasciata, Currant Fruit-worm.
Gortyna nitela, Stalk Borer.
Grapta progne, Spinous Currant Caterpillar.
Hyperchiria io, Io Moth.
Myelois convolutella, Gooseberry-worm.
Mytilaspis conchiformis, Oyster-shell Bark-louse.
Nematocampa filamentaria, Strawberry Geometer.
Nematus ventricosus, Imported Currant worm.
Pristiphora grossulariæ.
rufipes.
Spilosoma virginica, Yellow Bear.
Tetranychus, Red Spider.
Currant, Black.
Ægeria caudata, Black-currant Borer.
tipuliformis, Currant Borer.
Currant, Red.
Ægeria tipuliformis, Currant Borer.
Attacus cecropia, Cecropia Silkworm.
Doryphora 10-lineata, Colorado Potato-beetle.
Eupithecia interrupto-fasciata, Currant Fruit-worm.
Myzus ribis.
Currant, Wild.
Grapta progne, Spinous Currant Caterpillar.
Currant, Wild Black.
Ægeria caudata, Black-currant Borer.
Cypress Vine.
Agrotis ypsilon, Greasy Cutworm.

D

Dandelion.
Pyrrarctia isabella, Hedgehog Caterpillar.
Decayed Oak wood.
Mordella 8-punctata.
Decayed Wood.
Alaus oculatus, Snapping Beetle.
Decayed Wood.
Dendroides canadensis.
Dynastes tityus.
Lucanus dama, Pinching bug.
elaphus, Stag Beetle.
Decaying Vegetation.
Diabrotica longicornis, Corn Root-worm.
Myriapoda, Myriapods, Thousand-legs.
Dictamnus fraxinella.
Papilio cresphontes, Cresphontes Butterfly.
Dill.
Papilio asterias, Asterias Butterfly.
Diplopappus. (See Aster, Double-bristled.)
Dock.
Aphis rumicis. Bean Aphis.
Dock, Yellow.
Ceramica picta, Zebra Caterpillar.
Exartema fascianatum.
Dogbane, Apocynum.
Aphis apocyni.
Dogbane, Spreading. (Apocynum androsæmifolium.)
Chrysochus auratus, Golden Chrysochus.
Danais archippus, Archippus Butterfly.
Euchætes collaris.
Dog-fennel. (See May-weed.)
Dogwood, Cornus.
Aphis cornifoliæ, Dogwood-leaf Aphis.
Cœlodasys unicornis, Unicorn Apple-tree Caterpillar.
Hyperchiria io, Io Moth.
Œdemasia concinna, Red-humped Prominent.
Lycæna pseudargiolus, Azure-blue Butterfly.
Dogwood. Cornus paniculata.
Loxotænia rosaceana. Greater Leaf-Roller.
Dogwood, Flowering, Cornus florida.
Aphis cornifoliæ.
Dogwood, Red-osier.
Schizoneura cornicola.
Drummond Phlox.
Heliothis phloxiphagus, Phlox Heliothis.
Dutchman's Pipe, Aristolochia sipho.
Papilio philenor, Philenor Swallow-tail.
Dyer's Broom, Genista.
Aphis rumicis, Bean Aphis.

E

Egg Plant.
Doryphora 10-lineata, Colorado Potato-beetle.
Elder.
Aphis sambuci, Elder Aphis.
Attacus cecropia, Cecropia Silkworm.
Hyphantria textor, Fall Web-worm.
Macrodactylus subspinosus, Rose bug.

Elm.
Anisopteryx autumnata, Fall Canker-worm.
vernata. Spring Canker-worm.
Apatela americana, American Maple Moth.
Arctia phalerata, Harnessed Moth.
Callipterus ulmicola.
Ceratomia amyntor, Elm Sphinx.
Cimbex laportei.
Eugonia subsignaria.
Glyphina ulmicola, Aphis of the Elm-leaf Cockscomb Gall.
Grapta comma, Comma Butterfly.
interrogationis, Semicolon Butterfly.
progne, Spinous Currant Caterpillar.
Halesidota caryæ.
Hibernia tiliaria, Yellow Canker-worm.
Hyperchiria io, Io Moth.
Hyphantria textor, Fall Web-worm.
Lachnosterna fraterna, Kindred May-beetle.
fusca, Dark May-beetle.
pilosicollis, Hairy May-beetle.
Magdalis armicollis, Elm-tree Curculio.
Mytilaspis conchiformis, Oyster-shell Bark-louse.
Orgyia leucostigma, White-marked Tussock Moth.
Phigalia strigataria.
Saperda tridentata, Three-toothed Saperda.
Schizoneura americana.
rileyi, Woolly Aphis of the Elm-tree.
ulmi, Elm-leaf Aphis.
Semasia prunivora, Plum Moth.
Telea polyphemus, Polyphemus Silk-worm.
Tolype velleda, Velleda Lappet Moth.
Tremex columba, Pigeon Tremex.
Vanessa antiopa, Antiopa Butterfly.
Elm, American or White.
Callipterus ulmifolii.
Ceratomia amyntor, Elm Sphinx.
Grapta interrogationis, Semicolon Butterfly.
progne, Spinous Currant Caterpillar.
Phytoptus ulmi.
Elm, Red or Slippery.
Pemphigus ulmifusus. (Red-elm Gall-louse.)
Endive, Cichorium endivia.
Tychea erigeronensis.
Euonymus atropurpureus. (See Burning bush.)
Eupatorium.
Gortyna nitela, Stalk Borer.

F

False Indigo, Amorpha and Baptisia.
Hyperchiria io, Io Moth.
False Nettle, Bœhmeria cylindrica.
Grapta comma, Comma Butterfly.
Pyrameis atalanta, Atalanta Butterfly.
False Sycamore, Acer pseudo-platanus.
Drepanosiphum acerina.
Feverwort, Triosteum perfoliatum.
Sesia diffinis, Clear Wing.
Field Crops.
Agrotis clandestina, W-marked Cut-worm.
messoria, Dark-sided Cutworm.
saucia, Variegated Cutworm.
Elateridæ, Wire worms.
Figwort, Scrophularia nodosa.
Phorodon scrophulariæ.
Fir.
Hylotrupes bajalus.
Lophyrus abietis, Fir-tree Saw-fly.
Flax.
Leucania unipuncta, Army worm.
Fleabane, Canada, Erigeron canadense.
Siphonophora erigeronensis, Aphis of the Canada Fleabane.
Flowers.
Cistelidæ.
Eupithecia interrupto-fasciata, Currant Fruit-worm.
Gortyna nitela, Stalk Borer.
Mordellidæ.
Rhipiphoridæ.
Trachelides.
Flowers, Garden.
Agrotis messoria, Dark-sided Cutworm.
Caloptenus bivittatus, Striped Caloptenus.
Elateridæ, Wire worms.
Gortyna nitela, Stalk Borer.
Leucarctia acræa, Salt-marsh Caterpillar.
Mamestra renigera, White Bristly Cutworm.
Forest Trees.
Anisopteryx autumnata, Fall Canker-worm.
vernata, Spring Canker-worm.
Apatela americana, American Maple Moth.
lepusculina, Cottonwood Dagger.
oblinita, Smeared Dagger.
Apatura celtis, Eyed Emperor.
clyton, Tawny Emperor.
Argyrolepia quercifoliana, Oak-leaf Tortrix.
Attacus cecropia, Cecropia Silkworm.
Bostrichus.
Callosamia promethea, Prometheus Silkworm.
Catocala amatrix.
cara.
desperata.
neogama.
ultronia.
Ceratomia amyntor, Elm Sphinx.
Chrysophanus thoë, Thoë Butterfly.

Forest Trees.
Citheronia regalis, Royal Walnut Moth.
Clisiocampa americana, Apple-tree Tent Caterpillar.
sylvatica, Tent Caterpillar of the Forest.
Cressonia juglandis, Walnut Sphinx.
Dryocampa rubicunda, Green-striped Maple Worm.
senatoria, Senatorial Dryocampa.
Ecpantheria scribonia, Large Black Bear.
Endropia bilinearia.
Eucronia maia, Buck Moth.
Eugonia subsignaria.
Grapta comma, Comma Butterfly.
interrogationis, Semicolon Butterfly.
Halesidota tessellaris, Checkered Tussock Moth.
Hyperchiria io, Io Moth.
Hyphantria textor, Fall Web-worm.
Limenitis ursula, Ursula Butterfly.
Lithophane cinerea, Ash-gray Pinion.
Macrodactylus subspinosus, Rose bug.
Orgyia leucostigma, White-marked Tussock Moth.
Papilio ajax, Ajax Butterfly.
cresphontes, Philenor Swallow-tail.
troilus, Troilus Butterfly.
turnus, Turnus Butterfly.
Phycita nebulo, Apple Leaf-crumpler.
Pyrophila pyramidoides, Green Cream-spotted Grape-worm.
Fringe tree, Virginia, Ohionanthus.
Sphinx kalmiæ.
Fruit.
Euryomia inda, Indian Cetonian.
Fruit trees.
Ægeria exitiosa, Peach Borer.
Agrotis, Cutworms.
messoria, Dark-sided Cut-worm.
Aphidæ, Plant Lice.
Borers.
Bostrichus.
basilaris, Shagbark Hickory-tree Borer.
Carpocapsa pomonella, Codling Moth.
Cercopidæ and Fulgoridæ, Tree-hoppers and leaf-hoppers.
Chrysobothris femorata, Flat-headed Apple-tree Borer.
Clisiocampa americana, Apple-tree Tent Caterpillar.
Coccidæ, Bark Lice.
Elateridæ, Wire-worms.
Empretia stimulea, Saddle-back Moth.
Hyphantria textor, Fall Web-worm.
Lachnosterna, May-beetles.
fraterna, Kindred May-beetle.
fusca, Dark May-beetle.
pilosicollis, Hairy May-beetle.
Leucania unipuncta, Army-worm.
Fruit trees.
Limenitis ursula, Ursula Butterfly.
Lygus lineolaris, Tarnished Plant-bug.
Orgyia leucostigma, White-marked Tussock Moth.
Pempelia hammondi, Apple-leaf Skeletonizer.
Phycita nebulo, Apple Leaf-crumpler.
Psylla rubi, Blackberry Flea-louse.
Psyllidæ, Jumping Plant-lice.
Saperda candida, Round-headed Apple-tree Borer.
Schizoneura lanigera, Woolly Aphis of the Apple-tree.
Thyridopteryx ephemeræformis, Bagworm.
Tortrix malivorana, Lesser Apple-leaf Folder.
Fungus.
Agonoderus.
Amara.
Carabidæ, Predaceous Ground-beetles.
Chlænius.
Coccinella 9-notata, Nine-spotted Lady-bug.
5-notata.
Coccinellidæ, Lady bugs.
Cycloneda sanguinea Trim Lady-bug.
Evarthrus colossus.
Harpalus.
Hippodamia convergens, Convergent Lady-bird.
glacialis, Icy Lady-bug.
Megilla maculata, Spotted Lady-bug.
Myriapoda, Myriapods, Thousand-legs.
Pterostichus.
Schizoneura fungicola.

G

Galium. (See Bedstraw.)
Gerardia tenuifolia.
Junonia lavinia, Lavinia Butterfly.
Siphonophora gerardiæ.
German Ivy.
Rhopalosiphum dianthi.
Gladiolus.
Heliothis armigera, Corn worm.
Glycine. (See Ground Ant.
Golden Rod.
Chauliognathus.
Diabrotica longicornis, Corn Root-worm.
Euryomia inda, Indian Cetonian.
Siphonophora rudbeckiæ.
Golden-rod, Solidago rigida.
Siphonophora rudbeckiæ.
Golden-rod, Solidago serotina.
Siphonophora rudbeckiæ.
Gooseberry.
Ægeria tipuliformis, Currant Borer.
Agrotis clandestina, W-marked Cut-worm.

Gooseberry.
Caloptenus femur-rubrum, Red-legged Locust.
Cutworms.
Epicærus imbricatus, Imbricated Snout-beetle.
Eufitchia ribearia, Gooseberry Span-worm.
Grapta faunus.
Limenitis ursula, Ursula Butterfly.
Myelois convolutella, Gooseberry worm.
Myzus ribis.
Nematus ventricosus, Imported Currant worm.
Pristiphora grossulariæ.
rufipes.
Siphonophora lactucæ.
Spilosoma virginica, Yellow Bear.
Gooseberry, Wild.
Grapta progne, Spinous Currant Caterpillar.
Goosefoot Family, Chenopodiaceæ.
Aphis atriplicis.
Gourd family, Cucurbitaceæ.
Aphis cucumeris, Melon Plant-louse.
Grain.
Alucita, Grain Moths.
Blissus leucopterus, Chinch bug.
Bruchus granarius, Grain Bruchus.
Gelechia cerealella, Angoumois Grain Moth.
Gortyna nitela, Stalk Borer.
Leucania unipuncta, Army worm.
Leucarctia acræa, Salt-marsh Caterpillar.
Macrodactylus subspinosus, Rose bug.
Philometra serraticornis.
Tenebrio, Meal worms.
Tenebrioides mauritanica.
Tinea granella, Wolf Moth.
Grape.
Acoloithus americana, American Procris.
falsarius.
Ægeria polistiformis, Grape Root-borer.
Agrotis cupida.
saucia, Variegated Cutworm.
scandens, Climbing Cutworm.
ypsilon, Greasy Cutworm.
Alypia octomaculata, Eight-spotted Forester.
Amphicerus bicaudatus, Twig and Axil Borer.
Amphipyra pyramidoides, Green Cream-spotted Grape worm.
Anomala binotata, Two-spotted Vine-chafer.
lucicola, American Vine-chafer.
varians, Variable Vine-chafer.
vitis, Vine-chafer.
Apatela oblinita, Smeared Dagger.
Arctia phalerata, Harnessed Moth.
Grape.
Bostrichus basilaris, Shagbark Hickory-tree Borer.
Callidium amœnum.
Chœrocampa pampinatrix.
Cœliodes inæqualis, Grape Curculio.
Colaspis flavida, Grape-vine Colaspis.
Dactylosphæra vitifoliæ, Grape-leaf Gall-louse.
Darapsa myron, Hog Caterpillar of the Vine.
Daremma unculosa.
Deilephila chamænerii.
lineata, White-lined Sphinx.
Desmia maculata, Grape Leaf-folder.
Dyspteris abortivaria.
Elateridæ, Wire worms.
Eudryas grapta, Beautiful Wood-nymph.
unio, Pearly Wood-nymph.
Fidia viticida, Grape-vine Fidia.
Gall-making Aphides.
Graptodera chalybea, Grape-vine Flea-beetle.
Hyphantria textor, Fall Web-worm.
Lecanium vitis.
Macrodactylus subspinosus, Rose-bug.
Mamestra distincta.
Pelidnota punctata, Spotted Vine-chafer.
Penthina vitivorana, Grape-berry Moth.
Petrophora diversilineata.
Philampelus achemon, Achemon Sphinx.
pandorus, Satellite Sphinx.
Philometra serraticornis.
Phylloxera vitifoliæ, Grape Phylloxera.
Prionus imbricornis, Tile-horned Prionus.
laticollis, Broad-necked Prionus.
Psychomorpha epimenis, Grape-vine Epimenis.
Pterophorus periscelidactylus, Grape-vine Plume.
Pyrophila pyramidoides, Green Cream-spotted Grape-worm.
Rutelidæ, Vine Chafers.
Sciara inconstans, Fickle Midge.
Selandria vitis.
Siphonophora viticola, Grape-Louse.
Spilosoma virginica, Yellow Bear.
Tetranychus, Red Spider.
Thyreus abbotti, Abbott's Sphinx.
Grass.
Acridium americanum, American Locust.
var. ambiguum, American Locust, yellow var.
Agonoderus.
Agrotis, Cutworms.
c-nigrum, Spotted Cutworms.
saucia, Variegated Cutworm.
tessellata, Corn Cutworm.

Grass.
Amara.
Anisodactylus.
Arctia phalerata, Harnessed Moth.
Atrytone hobomok.
Blissus leucopterus, Chinch bug.
Byrrhus pilula.
Calathus gregarius.
Caloptenus bivittatus, Striped Caloptenus.
differentialis, Lubberly Caloptenus.
femur-rubrum, Red-legged Locust.
spretus, Rocky Mountain Locust.
Carabidæ, Predaceous Ground-beetles.
Chytolita morbidalis.
Coccinellidæ, Lady bugs.
Ctenucha virginica.
Debis portlandia.
Drasteria erechtea.
Elateridæ, Wire worms.
Galerita janus, Janus Ground-beetle.
Gortyna nitela, Stalk Borer.
Hadena devastatrix, Glassy Cutworm.
Harpalus.
Heliophila phragmitidicola.
Isosoma elymi, Wheat-straw Worm.
Lachnosterna fraterna, White Grub or Kindred May-beetle.
fusca, White Grub or Dark May-beetle.
pilosicollis, White Grub or Hairy May-beetle.
Laphygma frugiperda, Fall Army-worm.
Leucania pseudargyia.
unipuncta, Army worm.
Leucarctia acræa, Salt-marsh Caterpillar.
Macrodactylus subspinosus, Rose bug.
Megilla maculata, Spotted Lady-bug.
Melolonthidæ, White Grubs.
Neonympha canthus.
eurytris, Eurytris Butterfly.
gemma.
sosybius.
Nephelodes violans, Smooth Cutworm.
Pamphila mystic.
peckius, Peck's Skipper.
phylæus.
sassacus, Sassacus Skipper.
Patrobus longicornis.
Philometra serraticornis.
Platynus limbatus.
Plusia simplex, Celery worm.
Pseudoglossa lubricalis.
Pterostichus.
Satyrus alope, Alope Butterfly.
nephele, Nephele Butterfly.
Scepsis fulvicollis.
Schizoneura panicola.
Grass, Blue.
Caloptenus spretus, Rocky Mountain Locust.
Loxopeza atriventris.
Grass, Bottle. (See Grass, Foxtail.)
Grass, Crab, Panicum sanguinale.
Blissus leucopterus, Chinch bug.
Grass, Eragrostis pœoides, var. megastachya.
Glyphina eragrostidis.
Grass, Foxtail, Setaria.
Blissus leucopterus.
Grass, Foxtail, Bottle-grass, Setaria glauca.
Siphonophora setariæ.
Grass, Gymnostichum hystrix.
Isosoma hordei, Joint worm.
Grass, Herd's. (See Grass, Timothy.)
Grass, Hungarian.
Agrotis c-nigrum, Spotted Cutworm.
Blissus leucopterus, Chinch bug.
Leucania unipuncta, Army worm.
Grass, Lyme, Wild Rye, Elymus canadensis.
Isosoma hordei, Joint-worm.
Grass, Panicum.
Glyphina eragrostidis.
Siphonophora setariæ, Bottle-grass Aphis.
Grass, Panicum glabrum.
Schizoneura panicola.
Tychea panici.
Grass, Poa annua.
Rhizobius poæ.
Grass, Ray or Rye.
Elateridæ, Wire worms.
Grass, Timothy, Herd's grass.
Blissus leucopterus, Chinch bug.
Caloptenus spretus, Rocky Mountain Locust.
Cut worms.
Elateridæ, Wire worms.
Leucania unipuncta, Army worm.
Timothy Worms.
Grass, Woolly Beard, Erianthus alopecuroides.
Pamphila delaware.
Grasses, perennial.
Agrotis, Cutworms.
Elateridæ, Wire worms.
Lachnosterna, White Grubs.
Leaf-hoppers.
Leucania unipuncta, Army worm.
Grasses, Wild.
Blissus leucopterus, Chinch bug.
Ground Cherry, Physalis.
Doryphora 10-lineata, Colorado Potato-beetle.
Ground Cherry, Physalis pubescens.
Macrosila carolina, Tobacco worm.
Ground nut, Apios Glycine.
Eudamus bathyllus, Bathyllus Skipper.
Niscniades juvenalis.

H

Hackberry, Celtis.
Apatela rubricoma.
Apatura celtis, Eyed Emperor.
clyton, Tawny Emperor.
Libythea bachmanni.

Hackberry, Celtis occidentalis.
Sphinx drupiferarum.
Haw.
Conotrachelus cratægi, Quince Curculio.
Hawthorn. (See Thorn.)
Hay.
Blissus leucopterus, Chinch bug.
Hazel.
Apatela oblinita, Smeared Dagger.
Argyrolepia quercifoliana, Oak-leaf Tortrix.
Balaninus nasicus, Long-snouted Nut-weevil.
Chytolita morbidalis.
Cœlodasys unicornis, Unicorn Apple-tree Caterpillar.
Datana ministra, Yellow-necked Apple-tree Caterpillar.
Halesidota tessellaris, Checkered Tussock Moth.
Hibernia tiliara, Yellow Canker-worm.
Hyperchiria io, Io Moth.
Loxotænia rosaceana, Greater Leaf-roller.
Nematocampa filamentaria, Strawberry Geometer.
Telea polyphemus, Polyphemus Silk-worm.
Hedysarum.
Eudamus bathyllus, Bathyllus Skipper.
Helminthosporium.
Carabidæ, Predaceous Ground-beetles.
Coccinella 9-notata, Nine-spotted Lady-bug.
5-notata.
Diabrotica longicornis, Corn Root-worm.
Hemlock.
Hylotrupes bajulus.
Hemlock Lumber.
Callidium sp.
Hemp.
Acridium emarginatum, Emarginate Locust.
Heliothis armigera, Corn worm.
Plusia aurichalcea.
Henbane.
Doryphora 10-lineata, Colorado Potato-beetle.
Heuchera. (See Alum-root.)
Hibiscus.
Eudryas unio, Pearly Wood-nymph.
Hibiscus grandiflorus.
Amphalocera.
Heliothis armigera, Corn worm.
Hickory.
Actias luna, Luna Silkworm.
Amphicerus bicaudatus, Twig and Axil Borer.
Aphis caryella.
Bostrichus basilaris, Shagbark Hickory-tree Borer.
Callipterus caryæ.
Chion cinctus, Hickory Trunk Borer.
Hickory.
Chrysobothris femorata, Flat-headed Apple-tree Borer.
Citheronia regalis, Royal Walnut Moth.
Clisiocampa sylvatica, Tent Caterpillar of the Forest.
Cressonia juglandis, Walnut Sphinx.
Datana ministra, Yellow-necked Apple-tree Caterpillar.
Dicerca lurida.
Halesidota caryæ.
Hyphantria textor, Fall Web-worm.
Lachnus, Twig Lice.
caryæ, Hickory Plant-louse.
Lithophane cinerea, Ash-gray Pinion.
Nematocampa filamentaria, Strawberry Geometer.
Phycita juglandis, Walnut Leaf-crumpler.
Phylloxera caryæcaulis, Hickory Gall-aphis.
caryæ-globosa.
caryævenæ, Hickory-vein Gall-louse.
Ptinidæ.
Pyrophila pyramidoides, Green Cream-spotted Grape-worm.
Schizoneura caryæ, Hickory Blight.
Scolytus 4-spinosus, Hickory Bark-borer.
Selandria caryæ.
Telea polyphemus, Polyphemus Silk-worm.
Thecla calanus.
Tortrix rileyana, Walnut Tortrix.
Hickory, Bitter-nut.
Scolytus 4-spinosus, Hickory Bark-borer.
Hickory, Pignut.
Hyphantria textor, Fall Web-worm.
Ithycerus noveboracensis, New York Weevil.
Lachnus caryæ, Hickory Plant-louse.
Scolytus 4-spinosus, Hickory Bark-borer.
Hickory, Shagbark or Shell-bark.
Bostrichus basilaris, Shagbark Hickory-tree Borer.
Hyphantria textor, Fall Web-worm.
Phylloxera caryæfoliæ, Hickory Leaf-witherer.
Scolytus 4-spinosus, Hickory Bark-borer.
Holly.
Thecla strigosa, Streaked Thecla.
Hollyhock.
Plusia precationis, Thistle Plusia.
Pyrameis cardui, Thistle Butterfly.
huntera, Hunter's Butterfly.
Honey-locust.
Eburia quadrigeminata, Honey-locust Borer.
Macrobasis unicolor, Ash-gray Blister-beetle.

Honey-locust.
Telea polyphemus. Polyphemus Silk-worm.
Honeysuckle.
Ceramica picta, Zebra Caterpillar.
Chaitophorus lonicera.
Honeysuckle, Bush.
Sesia diffinis, Clear Wing.
Honeysuckle, Fly, Lonicera ciliata.
Melitæa phæton.
Honeysuckle, Tartarian.
Abia caprifolii.
Sesia diffinis, Clear Wing.
Hop.
Elateridæ, Wire-worms.
Grapta comma, Comma Butterfly.
interrogationis, Semicolon Butterfly.
Hypena evanidalis.
humuli, Hop-vine Moth.
Hyperchiria io, Io Moth.
Phorodon humuli, Hop Aphis.
Plusia balluca, Hop Plusia.
Pyrameis atalanta, Atalanta Butterfly.
Tetranychus, Red Spider.
Thecla humuli, Hop-vine Thecla.
Hop Tree, Ptelea trifoliata.
Papilio cresphontes, Cresphontes Butterfly.
Hornbeam, Carpinus.
Psylla carpini.
Horse-chestnut.
Loxotænia rosaceana, Greater Leaf-roller.
Orgyia leucostigma, White-marked Tussock Moth.
Parorgyia parallela.
Horsemint, Monarda.
Pholisora catullus.
Horse Nettle.
Doryphora 10-lineata, Colorado Potato-beetle.
juncta.
Horseradish.
Caloptenus bivittatus, Striped Caloptenus.
Loxotænia rosaceana, Greater Leaf-roller.
Pieris oleracea, Turnip Butterfly.
rapæ, European Cabbage worm.
virginiensis.

I

Indian Hemp, Apocynum cannabinum.
Botis penitalis.
Euchætes collaris.
Indian Plantain, Cacalia suaveolens.
Siphonophora rudbeckiæ.
Iris.
Elateridæ, Wire worms.
Ironweed, Vernonia fasciculata.
Aphis middletoni.
vernoniæ, Ironweed Aphis.
Ironweed, Vernonia noveboracensis.
Siphonophora rudbeckiæ.
Ironweed, Vernonia lindheimeriana.
Siphonophora rudbeckiæ.
Ivy, American. (See American Ivy.)
German. (See German Ivy.)

K

Knotweed.
Chrysophanus thoë, Thoë Butterfly.
Doryphora 10-lineata, Colorado Potato-beetle.
Gastrophysa polygoni.
Gortyna nitela, Stalk Borer.
Siphonophora polygoni. Knotweed Aphis.

L

Lamb's-quarters, Chenopodium album.
Ceramica picta, Zebra Caterpillar.
Diabrotica longicornis, Corn Root-worm.
Doryphora 10-lineata, Colorado Potato-beetle.
Larch.
Orgyia leucostigma, White-marked Tussock Moth.
Larch, American, Tamarack.
Chermes laricifoliæ, Larch Chermes.
Lachnus laricifex, Tamarack Aphis.
Samia columbia.
Laurel, Kalmia.
Sphinx kalmiæ.
Leguminosæ. (See Pulse Family.)
Lemon.
Papilio cresphontes, Cresphontes Butterfly.
Lettuce.
Agrotis c-nigrum, Spotted Cutworm.
Caloptenus spretus, Rocky Mountain Locust.
Elateridæ, Wire worms.
Plusia simplex, Celery worm.
Rhizobius lactucæ, Lettuce Earth-louse.
Siphonophora lactucæ.
Lichen.
Coccinella 9-notata, Nine-spotted Lady-bug.
5-notata.
sanguinea, Trim Lady-bug.
Coccinellidæ, Lady bugs.
Diabrotica longicornis, Corn Root-worm.
Hippodamia convergens, Convergent Lady-bug.
glacialis, Icy Lady-bug.
Megilla maculata, Spotted Lady-bug.
Lilac.
Ægeria syringæ, Lilac Borer.
Callosamia promethea, Prometheus Silkworm.

Lilac.
Daremma undulosa.
Loxotænia rosaceana, Greater Leaf-Roller.
Mytilaspis conchiformis, Oyster-shell Bark-louse.
Papilio troilus, Troilus Butterfly.
Pyrophila pyramidoides, Green Cream-spotted Grape-worm.
Sphinx chersis.
Spilosoma virginica, Yellow Bear.
Lily.
Gortyna nitela, Stalk Borer.
Lime-tree. (See Basswood.)
Linden.
Apatela americana, American Maple Moth.
Drepanosiphum tiliæ.
Lachnus longistigma.
Phytoptus.
Selandria tiliæ, Linden Saw-fly.
Linden, American. (See Basswood.)
Linden, European.
Saperda vestita, Hairy Saperda.
Tetranychus, Red Spider.
Lindera. (See Spice-bush.)
Liquidambar. (See Sweet-gum Tree.)
Lobelia.
Elateridæ, Wire worms.
Locust.
Attacus cecropia, Cecropia Silkworm.
Cylene robiniæ, Locust Borer.
Eudamus tityrus, Tityrus Skipper.
Hispides.
Hyperchiria io, Io Moth.
Xyleutes robiniæ, Locust-tree Carpenter Moth.
Locust, Black.
Datana ministra, Yellow-necked Apple-tree Caterpillar.
Ecpantheria scribonia, Large Black Bear.
Eudamus tityrus, Tityrus Skipper.
Hyperchiria io, Io Moth.
Xyleutes robiniæ, Locust-tree Carpenter Moth.
Locust, Viscid.
Eudamus tityrus, Tityrus Skipper.
Logs. (See Stumps and Logs.)
Lucerne, Medicago sativa.
Heliothis armigera, Corn worm.
Lupine.
Callidryas eubule, Danewort Butterfly.
Colias eurytheme, Eurytheme Butterfly.
philodice, Philodice Butterfly.
Lycæna scudderi.
Lupine, Blue.
Utetheisa bella.

M

Maize.
Blissus leucopterus, Chinch bug.
Caloptenus femur-rubrum, Red-legged Locust.
Mallow Family, Malvaceæ.
Pyrameis cardui, Thistle Butterfly, huntera, Hunter's Butterfly.
Mandrake. (See May-apple.)
Mangel Wurtzel, Beta vulgaris, var.
Silpha opaca.
Maple.
Ægeria acerni, Maple Ægerian.
Agrotis c-nigrum, Spotted Cutworm.
Apatela americana, American Maple Moth.
Attacus cecropia, Cecropia Silkworm.
Callosamia promethea, Prometheus Silkworm.
Eacles imperialis, Imperial Moth.
Elaphidion, Twig-pruners.
Hyphantria textor, Fall Web-worm.
Lachnosterna fraterna, Kindred May-beetle.
Lecanium acericola, Maple Bark-louse.
acericorticis.
Limacodes laticlavia.
Orgyia leucostigma, White-marked Tussock Moth.
Telea polyphemus, Polyphemus Silkworm.
Maple, Ash-leaved, Box-elder, Negundo.
Ægeria acerni, Maple Ægerian.
Chaitophorus negundinis.
Chrysobothris femorata, Flat-headed Apple-tree Borer.
Lecanium acericola, Maple-tree Bark-louse.
Phytoptus sp.
Maple, Norway, Pseudoplatanus.
Drepanosiphum acerina.
Maple, Red.
Dryocampa rubicunda, Green-striped Maple-worm.
Maple, Silver, White or Soft.
Ægeria acerni, Maple Ægerian.
Agrotis c-nigrum, Spotted Cutworm.
Chrysobothris femorata, Flat-headed Apple-tree Borer.
Dryocampa rubicunda, Green-striped Maple-worm.
Lecanium acericola, Maple-tree Bark-louse.
Pemphigus acerifolii.
Phytoptus quadripes.
Siphonophora acerifoliæ.
Maple, Sugar.
Glycobius speciosus, Sugar-maple Borer.
Phytoptus acericola.
Psylla annulata, Annulated Psylla.
Marigold, Pot, Calendula micrantha.
Siphonophora calenduiæ.
calendulella.
May-apple, Mandrake.
Euptoieta claudia.
May-weed, Dog-fennel.
Caloptenus spretus, Rocky Mountain Locust.

Meadow Grass.
Elateridæ, Wire worms.
Leucania unipuncta, Army worm.
Lachnosterna fraterna, White Grub of Kindred May-beetle.
fusca, White Grub of Dark May-beetle.
pilosicollis, White Grub of Hairy May-beetle.
Meadow-rue, Thalictrum.
Calpe canadensis.
Meadow-sweet, Spiræa ulmaria.
Siphonophora pisi, Green Dolphin.
Melon, Cantaleup.
Phacellura nitidalis, Pickle worm.
Melon, Musk.
Aphis cucumeris, Melon Plant-louse.
Melon, Nutmeg.
Aphis cucumeris, Melon Plant-louse.
Phacellura nitidalis, Pickle worm.
Melon. (See Watermelon.)
Melons.
Aphis cucumeris, Melon Plant-louse.
cucurbitæ.
Deilephila lineata, White-lined Sphinx.
Diabrotica 12-punctata.
vittata, Striped Cucumber-beetle.
Phacellura nitidalis, Pickle-worm.
Mignonette.
Ceramica picta, Zebra Caterpillar.
Pieris protodice, Southern Cabbage Butterfly.
rapæ, European Cabbage Worm.
Milkweed, Silkweed, Asclepias.
Danais archippus, Archippus Butterfly.
Gortyna nitela, Stalk Borer.
Milkweed, Silkweed, Asclepias cornuti.
Callipterus asclepiadis.
Siphonophora asclepiadis, Milkweed Aphis.
Milkweed, Silkweed, Asclepias obtusifolia.
Callipterus asclepiadis.
Milkweed, Silkweed, Asclepias syriaca.
Aphis lutescens.
Mint, Spearmint, Mentha viridis.
Siphonophora menthæ.
Morning-glory.
Cassida bivittata, Two-striped Tortoise-beetle.
nigripes, Black-legged Tortoise-beetle.
Cassidinæ, Tortoise-beetles.
Coptocycla aurichalcea, Golden Tortoise-beetle.
guttata, Mottled Tortoise-beetle.
Macrosila cingulata.
Spilosoma virginica, Yellow Bear.
Moss.
Byrrhus pilula.
Moss, on Oaks.
Hypropepia fucosa.
Mountain Ash.
Apatela occidentalis.
Mountain Ash.
Chrysobothris femorata, Flat-headed Apple-tree Borer.
Saperda candida, Round-headed Apple-tree Borer.
Selandria cerasi, Cherry Slug.
Mountain Mint, Monarda.
Pholisora catullus.
Mulberry, White.
Agrotis saucia, Variegated Cutworm.
Mustard.
Orchestris vittata, Striped Flea-beetle.
Pieris napi.
oleracea, Turnip Butterfly.
protodice, Southern Cabbage Butterfly.
rapæ, European Cabbage worm.
Plusia brassicæ, Cabbage Plusia.
Mustard, Hedge, Sisymbrium officinale.
Doryphora 10-lineata, Colorado Potato-beetle.
Myrica. (See Bayberry.)

N

Nasturtium.
Pieris rapæ, European Cabbage worm.
virginiensis.
Nectarine.
Conotrachelus nenuphar, Plum Curculio.
Nettle.
Grapta comma, Comma Butterfly.
interrogationis, Semicolon Butterfly.
Plusia chrysites.
iota.
simplex, Celery worm.
Psylla urticæcolens.
Pyrameis atalanta, Atalanta Butterfly.
huntera, Hunter's Butterfly.
cardui, Thistle Butterfly.
Vanessa milberti.
Nettle, Great Stinging, Urtica dioica.
Pyrameis atalanta, Atalanta Butterfly.
Siphonophora pisi, Green Dolphin.
Nettle, Small Stinging, Urtica urens.
Plusia interrogationis.
Nightshade.
Doryphora 10-lineata, Colorado Potato-beetle.
Nursery Stock.
Lachnosterna fusca, White Grub or Dark May-beetle.

O

Oak.
Acridium rubiginosum.
Anisota senatoria, Senatorial Dryocampa.
Anorthosia punctipennella.
Apatela occidentalis.
Argyrolepia quercifoliana, Oak-leaf Tortrix.

Oak.
Brenthus septentrionalis, Northern Brenthus.
Callipterus quercicola.
Catocala lineella.
Chrysobothris femorata, Flat-headed Apple-tree Borer.
Clisiocampa sylvatica, Tent Caterpillar of the Forest.
Datana ministra, Yellow-necked Apple-tree Caterpillar.
Drepanosiphum (?) quercifolii.
Dryocampa pellucida.
rubicunda, Rosy Dryocampa.
stigma.
Eacles imperialis, Imperial Moth.
Edema albifrons.
Elaphidion, Twig-pruners.
parallelum, Parallel Longhorn.
Endropia bilinearia.
Halesidota tessellaris, Checkered Tussock Moth.
Hispides.
Hyperchiria io, Io Moth.
Hyphantria textor, Fall Web-worm.
Lachnosterna fraterna, Kindred May-beetle.
fusca, Dark May-beetle.
pilosicollis, Hairy May-beetle.
Limenitis disippus, Disippus Butterfly.
Lucanus dama, Pinching bug.
elaphus, Stag Beetle.
Magdalis olyra.
Myzocallis bella.
Nisoniades juvenalis.
Orgyia leucostigma, White-marked Tussock Moth.
Parorgyia clintonis.
parallela.
Perophora melsheimeri.
Pyrophila pyramidoides, Green Cream-spotted Grape-worm.
Saturnia maia, Buck Moth.
Schizoneura fungicola.
quercí, Woolly Aphis of the Oak.
Telea polyphemus, Polyphemus Silk-worm.
Thecla calanus.
m-album.
strigosa, Streaked Thecla.
titus.
Tolype velleda, Velleda Lappet Moth.
Tortrix fervidana.
paludana.
Tremex columba, Pigeon Tremex.
Xyleutes robiniæ, Locust-tree Carpenter Moth.
Oak-apple.
Lithophane cinerea, Ash-gray Pinion.
Oak, Black.
Argyrolepia quercifoliana, Oak-leaf Tortrix.
Elaphidion villosum, Oak Twig-borer.
Oak, Black-jack.
Oak.
Cicada septendecim, Seventeen-year Locust.
Oak, Burr.
Argyrolepia quercifoliana, Oak-leaf Tortrix.
Ithycerus noveboracensis, New York Weevil.
Loxotænia rosaceana, Greater Leaf-roller.
Myzocallis bella.
Phytoptus querci.
Thecla strigosa, Streaked Thecla.
Oak, Iron.
Phylloxera rileyi, Oak-leaf Phylloxera.
Oak, Laurel or Shingle.
Callipterus hyalinus.
Oak, Pin.
Argyrolepia quercifoliana, Oak-leaf Tortrix.
Oak, Post.
Agrilus lateralis.
Oak, Red.
Argyrolepia quercifoliana, Oak-leaf Tortrix.
Callipterus quercifolii.
walshi.
Semasia prunivora, Plum Moth.
Xyleutes robiniæ, Locust-tree Carpenter Moth.
Oak, Scrub.
Limenitis ursula, Ursula Butterfly.
Oak, Swamp Chestnut.
Chaitophorus quercicola.
Oak, Swamp White.
Callipterus discolor.
punctata.
Phylloxera rileyi, Oak-leaf Phylloxera.
Oak, White.
Agrilus lateralis.
Argyrolepia quercifoliana, Oak-leaf Tortrix.
Chrysobothris femorata, Flat-headed Apple-tree borer.
Elaphidion villosum, Oak Twig-borer.
Lachnus quercifoliæ, Oak-leaf Lachnus.
Pandeleteius hilaris, Gray-sided Curculio.
Phylloxera rileyi, Oak-leaf Phylloxera.
Oak wood, Decayed. (See Decayed Oak wood.)
Oats.
Agrotis saucia, Variagated Cutworm.
Blissus leucopterus, Chinch bug.
Caloptenus spretus, Rocky Mountain Locust.
Diabrotica longicornis, Corn Root-worm.
Doryphora 10-lineata, Colorado Potato-beetle.
Elateridæ, Wire-worms.
Gelechia cerealella, Angoumois Grain Moth.

Oats.
Gortyna nitela, Stalk Borer.
Leucania unipuncta, Army worm.
Siphonophora avenæ, Grain Plant-louse.
Oleander.
Aphis nerii.
Onion.
Acridium americanum, American Locust.
Caloptenus spretus, Rocky Mountain Locust.
Elateridæ, Wire worms.
Orache, Garden, Atriplex.
Aphis rumicis, Bean Aphis.
Orange.
Papilio cresphontes, Cresphontes Butterfly.
Phytoptus oleivorus.
Osage Orange.
Flata conica.
Hydnocera pallipennis.
Hyphantria textor, Fall Web-worm.
Lecanium macluræ.
Ormenis pruinosa.
Ox-eye Daisy.
Macrodactylus subspinosus, Rose bug.

P

Papaw.
Papilio ajax, Ajax Butterfly.
Parsley Family. Umbelliferæ.
Papilio asterias, Parsnip worm.
Parsley.
Papilio asterias, Parsnip worm.
Parsnip.
Papilio asterias, Parsnip worm.
Siphocoryne pastinacæ.
Passion Flower.
Euptoieta claudia.
Passion Flower, Blue.
Agraulis vanillæ.
Passion Flower, Scarlet.
Agraulis vanillæ.
Pea.
Bruchidæ, Pea and Bean Weevils.
Bruchus granarius, Grain Bruchus.
pisi, Pea Weevil.
Callidryas eubule, Danewort Butterfly.
Ceramica picta, Zebra Caterpillar.
Colias eurytheme, Eurytheme Butterfly.
philodice, Philodice Butterfly.
Heliothis armigera, Corn worm.
Siphonophora pisi, Green Dolphin.
Spilosoma virginica, Yellow Bear.
Peach.
Ægeria exitiosa, Peach Borer.
Agrotis c-nigrum, Spotted Cutworm.
saucia, Variegated Cutworm.
Amphicerus bicaudatus, Twig and Axil Borer.
Anarsia lineatella, Peach-twig Borer.
Peach.
Anisopteryx antumnata, Fall Canker-worm.
vernata, Spring Canker-worm.
Aphis amygdali, Almond Aphis.
Arctia phalerata, Harnessed Moth.
Bostrichus basilaris, Shagbark Hickory-tree Borer.
Caloptenus spretus, Rocky Mountain Locust.
Chrysobothris femorata, Flat-headed Apple-tree Borer.
Clisiocampa sylvatica, Tent Caterpillar of the Forest.
Conotrachelus nenuphar, Plum Curculio.
Dicerca divaricata, Cherry-tree Borer.
Euryomia inda, Indian Cetonian.
Gortyna nitela, Stalk Borer.
Ithycerus noveboracensis, New York Weevil.
Lithophane picta.
Melanactes piceus, Wire-worm.
Myzus persicæ, Peach-tree Aphis.
Prodenia lineatella.
Pyrophila pyramidoides, Green Cream-spotted Grape-worm.
Saturnia maia, Buck Moth.
Tetranychus, Red Spider.
Pear.
Ægeria pyri, Pear-tree Borer.
Agrotis c-nigrum, Spotted Cutworm.
Amphicerus bicaudatus, Twig and Axil Borer.
Anthonomus pyri, Pear Weevil.
4-gibbus, Apple Curculio.
Aspidiotus harrisi, Harris's Bark-louse.
Callimorpha lecontei, Callimorpha Pear Caterpillar.
Carpocapsa pomonella, Codling Moth.
Chrysobothris femorata, Flat-headed Apple-tree Borer.
Cicada septendecim, Seventeen-year Locust.
Conotrachelus cratægi, Quince Curculio.
nenuphar, Plum Curculio.
Haltica helxines. Small Bronze Flea-beetle.
Hyphantria textor, Fall Web-worm.
Ips quadrisignatus.
Ithycerus noveboracensis, New York Weevil.
Lecanium pyri.
Œdemasia concinna, Red-humped Prominent.
Orgyia leucostigma, White-marked Tussock-Moth.
Phytoptus pyri.
Platycerus quercus.
Prionus laticollis, Broad-necked Prionus.
Psylla pyri, Pear Flea-louse.

Pear.
Pyrophila pyramidoides, Green Cream-spotted Grape-worm.
Selandria cerasi, Cherry Slug.
Tetranychus, Red Spider.
Tremex columba, Pigeon Tremex.
Pecan.
Callipterus caryæ.
Scolytus 4-spinosus, Hickory Bark Borer.
Pepper.
Doryphora 10-lineata, Colorado Potato-beetle.
Heliothis armigera, Corn worm.
Pepper. Cayenne.
Caloptenus spretus, Rocky Mountain Locust.
Pepper grass, Lepidium virginicum.
Arctia phalerata, Harnessed Moth.
Eutrapela transversata, Span worm.
Peronospora.
Diabrotica longicornis, Corn Root-worm.
Persimmon.
Actias luna, Luna Silkworm.
Aphis diospyri.
Citheronia regalis, Royal Walnut Moth.
Psylla sp.
Phaseolus perennis. (See Bean, Wild.)
Phlox.
Heliothis phloxiphagus, Phlox worm.
Phoma.
Loxopeza atriventris.
Picotee.
Elateridæ, Wire worms.
Pignut. (See Hickory, Pignut.)
Pigweed, Amarantus retroflexus.
Doryphora 10-lineata, Colorado Potato-beetle.
Pigweed. Chenopodium.
Aphis rumicis, Bean Aphis.
Gortyna nitela, Stalk Borer.
Pine.
Aphis pinicolens, Pine-inhabiting Aphis.
Callidium amœnum.
Callosamia promethae. Prometheus Silkworm.
Chalcophora virginiensis.
Chermes pinifoliæ.
Coccinellidæ, Lady bugs.
Curculionidæ, Snout Beetles.
Diraphia femoralis, Black-legged Diraphia.
vernalis, Jumping Plant-louse.
Eacles imperialis, Imperial Moth.
Hylobius pales, Pales Weevil.
Hylurgus terebrans, Boring Hylurgus.
Lachnus strobi, White-pine Lachnus.
Lophyrus abietis, Fir-tree Saw-fly.
Pissodes strobi, White-pine Weevil.
Platycerura furcilla.
Sphinx coniferarum.
Thecla humuli, Hop-vine Thecla.
Pine
Thecla niphon.
Urocerus albicornis.
Pine Lumber.
Callidium sp.
Pine, Pinus palustris.
Sphinx coniferarum.
Pine, Scotch.
Mytilaspis pinifolii, Pine-leaf Scale-insect.
Pine, White.
Lachnus strobi, White-pine Lachnus.
Lophyrus abbotti, Abbott's Saw-fly.
Mytilaspis pinifolii, Pine-leaf Scale-insect.
Pissodes strobi, White-pine Weevil.
Platycerura furcilla.
Schizoneura pinicola.
strobi, Pine-tree Blight.
Sphinx harrisi, Hawk Moth.
pineum, Hawk Moth.
Urocerus abdominalis.
Pink.
Elateridæ, Wire worms.
Plantain.
Arctia arge, Arge Tiger Moth,
isabella, Hedgehog Caterpillar.
phalerata, Harnessed Moth.
Ecpantheria scribonia, Large Black Bear.
Melitæa phæton.
Plusia precationis, Thistle Plusia.
simplex, Celery worm.
Pyrrharctia isabella, Hedgehog Caterpillar.
Spilosoma virginica, Yellow Bear.
Plantain, Plantago lanceolata.
Junonia lavinia, Lavinia Butterfly.
Plum.
Actias luna, Luna Silkworm.
Ægeria exitiosa, Peach Borer.
pictipes.
Anthonomus prunicida, Plum Gouger.
Apatela occidentalis.
superans, Green Chestnut-backed Caterpillar.
Aphis pruni, Plum Aphis.
Attacus cecropia, Cecropia Silkworm.
Callosamia promethea, Prometheus Silkworm.
Chrysobothris femorata, Flat-headed Apple-tree Borer.
Clisiocampa americana, Apple-tree Tent Caterpillar.
sylvatica, Tent Caterpillar of the Forest.
Cœlodasys unicornis, Unicorn Apple-tree Caterpillar.
Conotrachelus nenuphar, Plum Curculio.
Haltica helxines, Small Bronze Flea-beetle.
Hyalopterus pruni.
Ithycerus noveboracensis, New York Weevil.

Plum.
Limenitis disippus, Disippus Butterfly.
Macrodactylus subspinosus, Rose bug.
Œdemasia concinna, Red-humped Prominent.
Orgyia leucostigma, White-marked Tussock Moth.
Parorgyia parallela.
Phorodon humuli, var. mahaleb.
Phycita nebulo, Apple Leaf-crumpler.
Pyrophila pyramidoides, Green-spotted Grape-worm.
Samia cynthia, Ailanthus Silkworm.
Semasia prunivora, Plum Moth.
Sphinx drupiferarum.
Plum, Sloe.
Phorodon humuli, var. mahaleb.
Poison Ivy.
Phytoptus sp.
Pollen.
Coccinella.
sanguinea, Trim Lady-bird.
Coccinellidæ, Lady bugs.
Harpalus.
Hippodamia convergens, Convergent Lady-bird.
glacialis, Icy Lady-bug.
Megilla maculata, Spotted Lady-bird.
Polygonum.
Gortyna nitela, Stalk Borer.
Pomegranate.
Thecla isocrates.
Poplar.
Apatela americana, American Maple Moth.
Callosamia promethea, Promethus Silkworm.
Clisiocampa sylvatica, Tent Caterpillar of the Forest.
Gastropacha americana.
Hyperchiria io, Io Moth.
Limenitis disippus, Disippus Butterfly.
ursula, Ursula Butterfly.
Lithophane cinerea, Ash-gray Pinion.
Loxotænia rosaceana, Greater Leaf-roller.
Lucanus elephas, Stag Beetle.
Prionus laticollis, Broad-necked Prionus.
Pyrophila pyramidoides, Green Cream-spotted Grape-worm.
Smerinthus modestus.
Telea polyphemus, Polyphemus Silkworm.
Vanessa antiopa, Antiopa Butterfly.
Poplar, Balsam.
Pemphigus popularia, Poplar Gall-louse.
populi - globuli, Poplar Bullet Gall-louse.
populi-ramulorum.
populi-transversus.
populi-venæ, Poplar-vein Gall-louse.
Poplar, Balsam.
vagabundus, Vagabond Gall-louse.
Poplar, Lombardy.
Agrilus granulatus, Lombardy Poplar Borer.
Lachnosterna fraterna, Kindred May-beetle.
Prionus laticollis, Broad-necked Prionus.
Poppy.
Aphis rumicis, Bean Aphis.
Potato.
Agrotis messoria, Dark-sided Cutworm.
Baridius trinotatus, Potato-stalk Weevil.
Blister Beetles.
Caloptenus femur-rubrum, Red-legged Locust.
spretus, Rocky Mountain Locust.
Doryphora 10-lineata, Colorado Potato-beetle.
Drasteria erechtea, Clover Drasteria.
Elateridæ, Wire worms.
Epicauta cinerea, Margined Blister-beetle.
vittata, Striped Potato beetle.
Epitrix cucumeris, Cucumber Flea-beetle.
Gortyna nitela, Stalk Borer.
Lema trilineata, Three-lined Potato-beetle.
Lygus lineolaris, Tarnished Plant-bug.
Macrobasis unicolor, Ash-gray Blister-beetle.
Macrosila carolina, Tobacco worm.
5-maculata, Tobacco worm.
Prickly Ash.
Chrysophanus thoë, Thoë Butterfly.
Papilio cresphontes, Cresphontes Butterfly.
troilus, Troilus Butterfly.
Prickly Ash, Northern, Toothache-tree, Zanthoxylum americanum.
Chrysophanus thoë, Thoë Butterfly.
Privet, Ligustrum.
Daremma undulosa.
Pulmonaria angustifolia.
Plusia modesta.
Pulse Family, Leguminosæ.
Agrotis annexa, Cabbage Cutworm.
Aphis medicaginis.
Terias lisa, Lisa Butterfly.
Pumpkin.
Agrotis clandestina, W-marked cutworm.
Diabrotica vittata, Striped Cucumber-beetle.
Heliothis armigera, Corn worm.
Melittia cucurbitæ, Squash Borer.
Purslane.
Deilephila lineata, White-lined Sphinx.
Diabrotica longicornis, Corn Root-worm.

Q

Quince.
Conotrachelus cratægi, Quince Curculio.
nenuphar, Plum Curculio.
Datana ministra, Yellow-necked Apple-tree Caterpillar.
Phycita nebulo, Apple Leaf-crumpler.
Saperda candida, Round-headed Apple-tree Borer.
Telea polyphemus, Polyphemus Silk-worm.

R

Radish.
Deilephila lineata, White-lined Sphinx.
Orchestris vittata, Striped Flea-beetle.
Pieris napi.
oleracea, Turnip Butterfly.
rapæ, European Cabbage worm.
virginiensis.
Plusia brassicæ. Cabbage Plusia.
Ragweed, Ambrosia.
Megilla maculata, Spotted Lady-bug.
Ragweed, Ambrosia artemisiæfolia.
Diabrotica longicornis, Corn Root-worm.
Gortyna nitela, Stalk Borer.
Leucarctia acræa, Salt-marsh Caterpillar.
Loxotænia rosaceana, Greater Leaf-roller.
Telesilla cinereola.
Ragweed, Ambrosia psilostachya.
Siphonophora ambrosiæ.
Ragweed, Ambrosia trifida.
Diabrotica longicornis, Corn Root-worm.
Gortyna nebris, Stalk Borer.
Siphonophora rudbeckiæ.
Raphanus.
Pieris virginiensis.
Raspberry.
Ægeria rubi, Raspberry Root-borer.
Agrilus ruficollis, Raspberry Cane-borer.
Anatis 15-punctata, Fifteen-spotted Lady-bug.
Ceramica picta, Zebra Caterpillar.
Eupithecia interrupto-fasciata, Currant Fruit-worm.
Loxotænia rozaceana, Greater Leaf-roller.
Pemphigus rubi.
Prodenia lineatella.
Pyrophila pyramidoides, Green Cream-spotted Grape-worm.
Selandria rubi, Raspberry Slug.
Siphonophora rubi.
Synchlora rubivoraria, Raspberry Geometer.
Raspberry, Wild.
Loxotænia rosaceana, Greater Leaf-roller.
Rattle-box, Crotalaria.
Utetheisa bella.
Ray-grass. (See Grass, Ray- or Rye-.)
Red-bud.
Fidia viticida, Grape-vine Fidia.
Pyrophila pyramidoides, Green Cream-spotted Grape-worm.
Red Root.
Lycæna comyntas, Comyntas Butterfly.
Rhubarb.
Caloptenus spretus, Rocky Mountain Locust.
Gortyna nitela, Stalk Borer.
Rocket.
Cerostoma porrectella.
Rosaceæ. (See Rose Family.)
Rose.
Clisiocampa sylvatica, Tent Caterpillar of the Forest.
Empretia stimulea, Saddle-back Moth.
Hyphantria textor, Fall Web-worm.
Loxotænia rosaceana, Greater Leaf-roller.
Macrodactylus subspinosus, Rose bug.
Œdemasia concinna, Red-humped Prominent.
Orgyia leucostigma, White-marked Tussock Moth.
Phigalia strigataria.
Pyrophila pyramidoides, Green Cream-spotted Grape-worm.
Pyrrhia exprimens.
Selandria rosæ, Rose Slug.
Siphonophora, rosæ, Rose Aphis.
rosarum.
Smerinthus excæcatus, Blind-eyed Sphinx.
Telea polyphemus, Polyphemus Silk-worm.
Tetranychus, Red Spider.
Rose, Wild, Rosa blanda.
Penthina nimbatana.
Rose Family, Rosaceæ.
Pseudothyatira cymatophoroides.
Serica vespertina, Evening Silky Leaf-chafer.
Rosin-plant, Silphium integrifolium.
Siphonophora rudbeckiæ.
Rye.
Agrotis saucia, Variegated Cutworm.
Blissus leucopterus, Chinch bug.
Caloptenus spretus, Rocky Mountain Locust.
Elateridæ, Wire worms.
Isosoma hordei, Joint Worm.
Laphygma frugiperda, Fall Army-worm.
Leucania unipuncta, Army-worm.
Siphonophora avenæ, Grain Plant-louse.
Rye-grass. (See Grass, Ray- or Ray-.)

S

St. John's-wort, Hypericum kalmianum.
Aphis hyperici.
St. John's-wort, Hypericum prolificum.
Myzocallis hyperici.
Salsify.
Prodenia lineatella.
Salt Marsh Grass.
Leucarctia acræa, Salt-marsh Caterpillar.
Salvia.
Gortyna nitela, Stalk Borer.
Sassafras.
Callosamia promethea, Prometheus Silk-worm.
Hyperchiria io, Io Moth.
Papilio Troilus, troilus Butterfly.
Saw-grass, Saur-grass, Cladium effusum.
Pamphila palatka.
Scrub Grass.
Pamphila sassacus, Sassacus Skipper.
Sedge.
Satyrus alope, Alope Butterfly.
nephele, Nephele Butterfly.
Senecio cineraria. (See Cineraria.)
Senna.
Terias nicippe, Nicippe Butterfly.
Septoria.
Diabrotica longicornis, Corn Root-worm.
Shad Bush. (See June Berry.)
Shag-bark Hickory. (See Hickory, Shag-bark or Shell-bark.)
Shell-bark Hickory. (See Hickory, Shag-bark or Shell-bark.)
Shell-flower. (See Turtle-head.)
Shepherd's Purse.
Aphis rumicis, Bean Aphis.
Siphonophora pisi, Green Dolphin.
Shrubs.
Agrotis messoria, Dark-sided Cutworm.
scandens, Climbing Cutworm.
Anomala binotata, Two-spotted Vine-chafer.
Callosamia promethea, Prometheus Silkworm.
Hibernia tiliaria, Yellow Canker-worm.
Leucania unipuncta, Army worm.
Macrodactylus subspinosus, Rose bug.
Tetranychus, Red Spider.
Silkweed. (See Milkweed.)
Smartweed.
Apatela oblinita, Smeared Dagger.
Arctia phalerata, Harnessed Moth.
Arsilonche henrici.
Ceramica picta, Zebra Caterpillar.
Diabrotica longicornis, Corn Root-worm.
Loxotænia rosaceana, Greater Leaf-roller.
Spilosoma virginica, Yellow Bear.
Smilax.
Thecla smilacis.
Smoke Tree, Venetian Sumach.
Blepharida rhois, Jumping Sumach-beetle.
Snakeroot, Black, Cimicifuga racemosa.
Lycæna comyntas, Comyntas Butterfly.
pseudargiolus.
Snakeroot, Virginia. (See Virginia Snake-root.)
Snowball, Viburnum opulus, var. roseum.
Aphis viburni, Snowball Aphis.
Snowberry, Symphoricarpus.
Ceramica picta, Zebra Caterpillar.
Hyperchiria io, Io Moth.
Sesia thysbe, Thysbe Clear Wing.
tenuis.
Snowberry, Symphoricarpus vulgaris.
Aphis symphoricarpi, Snowberry Aphis.
Tortrix rileyana, Walnut Tortrix.
Snowdrop-tree, Halesia.
Callosamia promethea, Prometheus Silkworm.
Soapwort, Bouncing Bet, Saponaria officinalis.
Leucania unipuncta, Army-worm Moth.
Sorghum.
Caloptenus spretus, Rocky Mountain Locust.
Blissus leucopterus, Chinch bug.
Sipha maidis, Corn Aphis.
Sorrel.
Chrysophanus americana, American Copper Butterfly.
Spilosoma virginica, Yellow Bear.
Sorrel, Field, Rumex acetosella.
Aphis rumicis, Bean Aphis.
Sow-thistle, Sonchus oleraceus.
Siphonophora lactucæ.
sonchi.
Spearmint. (See Mint.)
Spice-bush, Benzoin, Lindera.
Callosamia promethea, Prometheus Silkworm.
Papilio troilus, Troilus Butterfly.
Spider Flower.
Pieris monuste.
Spinach.
Agrotis c-nigrum, Spotted Cutworm.
Gortyna nitela, Stalk Borer.
Spiræa.
Gortyna nitela, Stalk Borer.
Saturnia maia, Buck Moth.
Spruce.
Chermes abieticolens, Adelges of the Spruce.
Hylotrupes bajalus.
Lophyrus abietis, Fir-tree Saw-fly.
Orgyia leucostigma, White-marked Tussock Moth.
Spruce, Black.
Lachnus abietis, Spruce-tree Lachnus.
Spruce lumber.
Callidium sp.

Spurge, Euphorbia marginata.
Siphonophora euphorbicola, Margined spurge Aphis.
Spurge, Spotted, Euphorbia maculata.
Siphonophora euphorbiæ, Spotted-spurge Aphis.
Squash.
Aphis cucumeris, Melon Plant-louse.
Diabrotica 12-punctata.
longicornis, Corn Root-worm.
vittata, Striped Cucumber-beetle.
Elateridæ, Wire worms.
Melittia cucurbitæ, Squash Borer.
Phacellura nitidalis, Pickle worm.
Siphonophora cucurbitæ.
Squash, Hubbard.
Melittia cucurbitæ, Squash Borer.
Stock, Ten Weeks'.
Orchestris vittata, Striped Flea-beetle.
Stock, Virginia.
Orchestris vittata, Striped Flea-beetle.
Stonecrop, Sedum.
Euptoieta claudia.
Straw.
Pyralis farinalis, Meal Snout-moth.
Strawberry.
Allorhina nitida.
Anarsia lineatella, Strawberry Crown Miner.
Anchylopera fragariæ, Strawberry Leaf-roller.
Angerona crocataria.
Colaspis flavida, Grape-vine Colaspis.
Elateridæ, Wire worms.
Emphytus maculatus, Strawberry Saw-fly.
Lachnosterna fusca, White Grub or Dark May-beetle.
Leucania unipuncta, Army worm.
Loxotænia rosaceana, Greater Leaf-roller.
Melolonthidæ, White Grubs.
Nematocampa filamentaria, Strawberry Geometer.
Siphonophora fragariæ, Strawberry Aphis.
Tyloderma fragariæ, Strawberry Crown-borer.
Strawberry, Wild.
Anarsia lineatella, Strawberry Crown Miner.
Loxotænia rosaceana, Greater Leaf roller.
Stumps and Logs.
Bolitophagus cornutus.
Sumach.
Blepharida rhois, Jumping Sumach-beetle.
Citheronia regalis, Royal Walnut Moth.
Datana ministra, Yellow-necked Apple-tree Caterpillar.
perspicua.
Loxotænia rosaceana, Greater Leaf-roller.
Pemphigus rhois, Sumach Gall Plant-louse.
Sumach, Venetian. (See Smoke Tree.)
Sunflower, Helianthus.
Aphis helianthi.
Diabrotica longicornis, Corn Root-worm.
Pyrameis cardui, Thistle Butterfly.
huntera, Hunter's Butterfly.
Spilosoma virginica, Yellow Bear.
Sunflower, Helianthus decapetalus.
Ecpantheria scribonia, Large Black Bear.
Sunflower, Wild.
Ecpantheria scribonia, Large Black Bear.
Sunflower, Wild, Helianthus grosse-serratus.
Gelechia flavocostella.
Loxotænia rosaceana, Greater Leaf-roller.
Sweet Briar.
Serica Respertina, Evening Silky Leaf-chafer.
Sweet Fennel.
Papilio asterias, Asterias Butterfly.
Sweet Fern.
Hyperchiria io, Io Moth.
Sweet Flag, Acorus calamus.
Diraphia calamorum, Calamus Diraphia.
maculipennis, Spotted-winged Diraphia.
Sweet-gum Tree, Liquidambar.
Actias luna, Luna Silkworm.
Callosamia promethea, Prometheus Silkworm.
Eacles imperialis, Imperial Moth.
Sweet-pea.
Siphonophora pisi, Green Dolphin.
Sweet Potato.
Cassida bivittata, Two-striped Tortoise-beetle.
nigripes, Black-legged Tortoise-beetle.
Cassididæ, Tortoise Beetles.
Coptocycla aurichalcea, Golden Tortoise-beetle.
guttata, Mottled Tortoise-beetle.
Macrosila cingulata.
Sweet William.
Elateridæ, Wire worms.
Sycamore.
Eacles imperialis, Imperial Moth.
Hyphantria textor, Fall Web-worm.
Telea polyphemus, Polyphemus Silk-worm.
Tremex columba, Pigeon Tremex.

T

Tamarack. (See Larch, American.)
Tansy, Tanacetum vulgare.
Siphonophora tanaceti, Tansy Aphis.

Tartarian Honeysuckle. (See Honeysuckle, Tartarian.)
Thistle.
Aphis carduella.
Diabrotica longicornis, Corn Root-worm.
Gortyna cataphracta.
Plusia chrysites.
precationis, Thistle Plusia.
Pyrameis cardui, Thistle Butterfly.
huntera, Hunter's Butterfly.
Thistle, Blessed, Cnicus.
Pyrameis cardui, Thistle Butterfly.
huntera, Hunter's Butterfly.
Thistle, Canada.
Siphonopora rudbeckiæ.
Thistle, Cirsium lanceolatum.
Doryphora 10-lineata, Colorado Potato-beetle.
Loxotænia rosaceana, Greater Leaf-roller.
Thistle, Cotton, Onopordon acanthium.
Pyrameis cardui, Thistle Butterfly.
huntera, Hunter's Butterfly.
Thistle, Plumeless, Carduus.
Pyrameis cardui, Thistle Butterfly.
huntera, Hunter's Butterfly.
Thistle, Spear.
Pyrameis cardui, Thistle Butterfly.
Thorn, Hawthorn, Cratægus.
Datana ministra, Yellow-necked Apple-tree Caterpillar.
perspicua.
Gortyna cataphracta.
Œdemasia concinna, Red-humped Prominent.
Papilio turnus, Turnus Butterfly.
Pyrophila pyramidoides, Green Cream-spotted Grape-worm.
Saperda candida, Round-headed Apple-tree Borer.
Sesia thysbe, Thysbe Clear Wing.
Telea polyphemus, Polyphemus Silk-worm.
Thecla humuli, Hop-vine Thecla.
strigosa, Streaked Thecla.
Thorn, Cratægus punctata.
Aphis cratægifoliæ, Thorn-leaf Aphis.
Thorn, Scarlet-fruited or White, Cratægus coccinea.
Lagria hirta.
Siphonophora cratægi.
Thorn Apple, Apple of Peru.
Doryphora 10-lineata, Colorado Potato-beetle.
Tick-trefoil, Desmodium.
Lycæna comyntas, Comyntas Butterfly.
Tick-trefoil, Desmodium dillenii.
Eudamus bathyllus, Bathyllus Skipper.
Tick-trefoil, Desmodium marilandicum.
Lycæna comyntas, Comyntas Butterfly.
Tobacco.
Agrotis ypsilon, Greasy Cutworm.
Caloptenus femur-rubrum, Red-legged Locust.
Tobacco.
spretus, Rocky Mountain Locust.
Doryphora 10-lineata, Colorado Potato-beetle.
Heliothis armigera, Corn worm.
Macrosila carolina, Tobacco worm.
5-maculata, Tomato worm.
Tomato.
Agrotis ypsilon, Greasy Cutworm.
Doryphora 10-lineata, Colorado Potato-beetle.
Epicauta cinerea, Margined Blister beetle.
vittata, Striped Potato-beetle.
Gortyna nitela, Stalk Borer.
Heliothis armigera, Corn worm.
Macrosila carolina, Tobacco worm.
5-maculata, Tomato worm.
Megoura solani.
Toothache-tree. (See Prickly Ash, Northern.)
Touch-me-not, Wild, Impatiens fulva.
Aphis impatiens, Touch-me-not Aphis.
Trees.
Agrotis clandestina, W-marked Cutworm.
messoria, Dark-sided Cutworm.
scandens, Climbing Cutworm.
Anisopteryx autumnata, Fall Canker-worm.
Buprestidæ, Saw-horned Wood-borers.
Byrrhus pilula.
Hibernia tiliaria, Yellow Canker-worm.
Lachnosterna fraterna, Kindred May-beetle.
fusca, Dark May-beetle.
pilosicollis, Hairy May-beetle.
Lachnus, Twig Lice.
Leucania unipuncta, Army worm.
Macrodactylus subspinosus, Rose bug.
Melanotus fissilis.
Tetranychus, Red Spider.
Trees, Deciduous.
Attacus cecropia, Cecropia Silkworm.
Callosamia promethea, Prometheus Silkworm.
Cicada septendecim, Seventeen-year Locust.
Lachnosterna fraterna, Kindred May-beetle.
fusca, Dark May-beetle.
pilosicollis, Hairy May-beetle.
Trees, Soft-wooded.
Xiphidra albicornis.
Trumpet Creeper, Tecoma radicans.
Psychomorpha epimenis, Grape-vine Epimenis.
Tulip.
Aphis tulipæ.
Rhopalosiphum tulipæ.
Siphonophora tulipæ.
Tulip-tree.
Callosamia promethea, Prometheus Silkworm.

Tulip-tree.
Lucanus elaphus, Stag Beetle.
Siphonophora liriodendri.
Turnip.
Caloptenus spretus, Rocky Mountain Locust.
Ceramica picta, Zebra Caterpillar.
Deilephila lineata, White-lined Sphinx.
Elateridæ, Wire worms.
Leucania unipuncta, Army worm.
Orchestris vittata, Striped Flea-beetle.
Pieris oleracea, Turnip Butterfly.
rapæ European Cabbage worm.
virginiensis.
Pionea rimosalis, Cabbage Pionea.
Plusia brassicæ, Cabbage Plusia.
Plutella cruciferarum, European Cabbage Web Moth.
Turnip, Rutabaga.
Ceramica picta, Zebra Caterpillar.
Pieris rapæ, European Cabbage worm.
Turtle-head, Snake head, Shell-flower, Chelone glabra.
Melitæa phæton.

U

Umbelliferæ. (See Parsley Family.)
Uredo.
Diabrotica longicornis, Corn Root-worm.
Ustilago.
Coccinella 9-notata, Nine-spotted Lady-bug.
5-notata.
Diabrotica longicornis, Corn Root-worm.

V

Vegetables, Garden.
Agrotis clandestina, W-marked Cut-worm.
c-nigrum, Spotted Cutworm.
herilis, Western Striped Cutworm.
lubricans.
saucia, Variegated Cutworm.
subgothica, Dingy Cutworm.
ypsilon, Greasy Cutworm.
Caloptenus bivittatus, Striped Caloptenus.
femur-rubrum, Red-legged Locust.
spretus, Rocky Mountain Locust.
Ceramica picta, Zebra Caterpillar.
Gortyna nitela, Stalk Borer.
Hadena devastatrix, Glassy Cut-worm.
Leucarctia acræa, Salt-marsh Caterpillar.
Macrodactylus subspinosus, Rose bug.
Mamestra subjuncta, Speckled Cut-worm.
Melolonthidæ, White Grubs.
Pionea forficialis, Cabbage-garden Pebble Moth.
Vegetables, Garden.
Plutella cruciferarum, European Cabbage Web Moth.
Psylliodes punctulata, Punctulated Flea-beetle.
Pyrrharctia arge, Arge Tiger Moth.
Verbena.
Dendroptus sp., Verbena Mite.
Siphonophora verbenæ, Verbena, Aphis.
Spilosoma virginica, Yellow Bear.
Vervain, Blue, Verbena hastata.
Adipsophanes miscellus.
Crambodes talidiformis.
Loxotænia rosaceana, Greater Leaf-roller.
Vetch, Tufted, Vicia cracca.
Aphis rumicis, Bean Aphis.
Vetchling, Everlasting Pea, Lathyrus.
Nisoniades juvenalis.
Violet.
Argynnis alcestis.
aphrodite Aphrodite Butterfly.
atlantis.
bellona.
cybele.
egleis.
diana, Diana butterfly.
idalia, Idalia butterfly.
myrina.
Euptoieta claudia.
Virginia Creeper.
Acoloithus americana, American Procris.
falsarius.
Citheronia regalis, Royal Walnut Moth.
Eudryas grata, Beautiful Wood-nymph.
Pelidnota punctata, Spotted Vine-chafer.
Philampelus achemon, Achemon Sphinx.
pandorus, Satellite Sphinx.
Thyreus abbotti, Abbott's Sphinx.
Virginia Snakeroot, Aristolochia serpentaria.
Papili. philenor, Philenor Swallow-tail.

W

Walnut.
Actias luna, Luna Silkworm.
Callipterus caryæ.
Citheronia regalis, Royal Walnut Moth.
Clisiocampa sylvatica, Tent Caterpillar of the Forest.
Cressonia juglandis, Walnut Sphinx.
Datana ministra, Yellow-necked Apple-tree Caterpillar.
Hyphantria textor, Fall Web-worm.
Orgyia leucostigma, White-marked Tussock Moth.
Phycita juglandis, Walnut Leaf-crumpler.
Schizoneura caryæ, Hickory Blight.
Telea polyphemus, Polyphemus Silkworm.

Walnut, Black.
Datana ministra, Yellow-necked Apple-tree Caterpillar.
Hyphantria textor, Fall Web-worm.
Melanotus communis, Wire worm.
fissilis, Wire worm.
Orgyia leucostigma, White-marked Tussock Moth.
Phycita juglandis, Walnut Leaf-crumpler.
Tortrix rileyana, Walnut Tortrix.
Walnut, White. (See Butternut.)
Watermelon.
Aphis cucumeris, Melon Plant-louse.
Deilephila lineata, White-lined Sphinx.
Weeds.
Acridium americanum, American Locust.
var. ambiguum, American Locust, Yellow var.
emarginatum, Emarginate Locust.
Agrotis saucia, Variegated Cutworm.
subgothica, Dingy Cutworm.
tessellata, Striped Cutworm.
Anomala binotata, Two-spotted Vine-chafer.
Blissus leucopterus, Chinch bug.
Caloptenus bivittatus, Striped Caloptenus.
differentialis, Lubberly Caloptenus.
Gortyna nitela, Stalk Borer.
Leucarctia acræa, Salt-marsh Caterpillar.
Œdipoda carolina, Carolina Locust.
Phlœtometra serraticornis.
Tragocephala, Goathead Locusts.
viridifasciata, var. infuscata, Dusky Locust.
var. virginianana, Green-striped Locust.
Wheat.
Acridium americanum, American Locust.
Agriotes mancus, Wheat Wire worm.
saucia, Variegated Cutworm.
Blissus leucoptenus Chinch bug.
Caloptenus femur-rubrum, Red-legged Locust.
spretus, Rocky Mountain Locust.
Cecidomyia destructor, Hessian Fly.
Diplosis tritici, Wheat Midge.
Elateridæ, Wire-worms.
Gelechia cerealella, Angoumois Grain Moth.
Gortyna nitela, Stalk Borer.
Heliophila harveyi, Wheat-head Armyworm.
Isosoma elymi, Wheat-straw Worm.
hordei, Joint Worm.
Lachnosterna fusca, White Grub of Dark May-beetle.
Laphygma frugiperda, Fall Armyworm.
Leucania unipuncta, Army worm.
Wheat.
Prodenia commelinæ, Wheat Cutworm.
Siphonophora avenæ, Grain Plant-louse.
Tinea granella, Wolf Moth.
Wheat, Winter.
Blissus leucopterus, Chinch bug.
Wild Liquorice, Galium circæzans.
Aphis circæzandis.
Wild Rye. (See Grass, Lyme-.)
Willow.
Actias luna, Luna Silkworm.
Ægeria anthracipennis.
Apatela oblinita, Smeared Dagger.
Attacus cecropia, Cecropia Silkworm.
Batrachedra salici-pomonella.
Cimbex laportei.
Chaitophorus salicicola.
viminalis.
Dolerus arvensis.
Ecpantheria scribnia, Large Black Bear.
Gelechia gallægenitella.
Grapta faunus,
j-album.
Halesidota caryæ.
Hyperchiria io, Io Moth.
Hyphantria textor, Fall Web-worm.
Lachnus salicelis.
salicicola, Plant-louse of the Willow.
Limenitis arthemis.
disippus, Disippus Butterfly.
ursula, Ursula Butterfly.
Lucanus dama, Pinching Bug.
Nematus salicis-pisum.
salicis-pomum.
ventralis.
Nymphalis disippus, Disippus Butterfly.
Oryssus affinis.
hæmorrhoidalis.
manurus.
Saturnia maia, Buck Moth.
Siphonophora salicicola, Willow Aphis.
Telea polyphemus, Polyphemus Silkworm.
Thecla acadica.
Vanessa antiopa, Antiopa Butterfly.
Willow, Black.
Aspidiotus salicis-nigræ, Black-willow Bark-louse.
Rhopalosiphum salicis.
Willow, Gray.
Lachnus dentatus, Spotted Willow Aphis.
Mytilaspis salicis, Willow Bark-louse.
Willow, Heart-leaved.
Euura salicis-ovum.
Phytoptus salicicola.
Phytoptus sp.
Willow, Low-bush, Salix humilis.
Euura orbitalis.
salicis-gemma.
Willow, Shining.
Chaitophorus viminalis.
Rhopalosiphum salicis.

Willow, Weeping.
Chaitophorus viminalis.
Nematus trilineatus.
Rhopalosiphum salicis.
Willow, White.
Chaitophorus smithiæ.
Euura salicicola.
Nematus ventralis.
Willow-herb, Epilobium.
Eudryas grata, Beautiful Wood-nymph.
Willow-herb, Epilobium angustifolium.
Daremma undulosa.
Deilephila chamænerii.
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MISCELLANEOUS ESSAYS

ON

ECONOMIC ENTOMOLOGY

BY THE

STATE ENTOMOLOGIST

AND HIS

ENTOMOLOGICAL ASSISTANTS.

SPRINGFIELD, ILL.:
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1886.

NOTE.

A recent opinion of the Attorney General makes it doubtful whether the State Entomologist of Illinois has a right, under the laws referring to that office (to some extent inconsistent and conflicting), to prepare any other than a biennial report; and a change in practice of the State Board of Contracts leaves no doubt whatever that a report published this year could not be illustrated. As an elaborate monograph of insects injurious to Indian corn was intended as the principal part of my entomological report for 1885, and as this article certainly should not be published without a large number of excellent figures, I have decided, under existing circumstances, not only to withhold this paper, but also to refrain from presenting any formal report for 1885, leaving it to the State Legislature to provide for the proper illustration of the reports hereafter, and to remove the present inconsistencies of the law. Unwilling, however, that the work of the office for the past year should be without representation in the Transactions of the State Board of Agriculture, with which the entomological report has been annually published for the last ten years, I have submitted to the Board, at the request of its Secretary, C. F. Mills, Esq., the following miscellaneous essays on economic entomology, summarizing the results of such part of our operations as may well be published without cuts.

A running account of the principal entomological events and observations of the year is followed by a somewhat elaborate report of experiments with insecticides for the codling moth and curculios in apple orchards; other articles are offered presenting the results of recent observations and experiments upon the corn plant louse, upon some of the most destructive of our common grasshoppers, and upon a miscellaneous series of insects of Livingston county; and a list of corn insects with a bibliography of the economic literature relating to them is also published as an introduction to a monograph on insects affecting corn, to be presented hereafter.

S. A. Forbes,
State Entomologist.

University of Illinois, March 1, 1886.

THE ENTOMOLOGICAL RECORD FOR 1885.

By S. A. FORBES.

To the economic entomologist the season of 1885 was not especially noticeable, except for an extraordinary outbreak of two or three of our common species of grasshoppers in the western part of the State. It seems, however, not impossible that the year will be remembered also for the first indications of one of the customary periodic uprisings of two of our most destructive insects, viz: the chinch bug and the army worm, both of which were evidently upon the increase in certain parts of the State, and likely to multiply injuriously another year, provided the weather is favorable for their reproduction.

Frequent complaint having reached me of injuries to lawns by ANTS of the various species which throw up mounds of earth, I have recommended the use of bisulphide of carbon to destroy these colonies, invariably, according to the accounts of my correspondents, with success. A hole six inches deep should be made through the middle of the mound, an ounce or more of bisulphide of carbon being afterwards poured in. The hole should then be filled and packed with earth. The volatile poisonous fluid will rapidly evaporate with deadly effect upon the ants. Thinking it likely that gasoline might be substituted for this somewhat expensive, dangerous, and highly disagreeable fluid, we experimented with the former liquid upon a colony of these insects at Champaign. Placed under a bell jar and exposed to the fumes of gasoline, the ants commenced to die in eight minutes, although not all had perished at the end of two hours. In sixteen hours, however, all were dead. Tried in the field, the experiment was a practical failure, three ounces of gasoline poured into a hole made in the middle of an ant hill having, practically, no effect at the end of twenty-one hours. This result was confirmed by a second trial. Although the odor of the gasoline lingered in the earth two and a quarter hours after the application, the ants were apparently not incommoded. It is possible, however, that larger quantities might produce the effect sought for.

The EUROPEAN CABBAGE WORM (*Pieris rapæ*) has clearly been less abundant during the past season throughout that part of the State under our observation, than during the year preceding. The same scarcity was noted by several of my correspondents. Dr. Goding, for instance, writing from Livingston county on the 24th July,

reported that it was difficult to find a single cabbage worm in the field; and Dr. Boardman, in August, informed me that they were very much less abundant in Stark county than usual. This difference, so favorable to the horticulturist, was due apparently to the continued prevalence of the destructive disease of the cabbage worm first reported by me in September, 1883.

Numerous examples of its extraordinary destructiveness occured in the course of our observations. Visiting a cabbage field near Champaign late in August, the owner of which had reported a few days previously that it was being destroyed by the cabbage worm, we failed to find, on twenty minutes' search, a single living larva, the leaves being, however, badly riddled, and the dried and blackened remnants of the dead cabbage worms giving unmistakable evidence of their recent presence.

Hoping to arrange experiments for the artificial propagation of this disease at a distance, where it had not yet appeared, I wrote to several of my entomological correspondents, inquiring whether it was discernible in their vicinities. From Dr. Lintner, State Entomologist of New York, I learned that it had appeared in that State, information to the same effect coming also from Mr. Goff, of the New York Experiment Station. In a subsequent letter, the latter gentleman contributed also the interesting information that Prof. Arthur, the botanist of the Station, had experimented with reference to the contagious character of the disease by feeding portions of the bodies of larvæ, recently dead, to still living and healthy worms, the effect being the speedy sickness and death of those thus treated. From William Saunders, Esq., of Ontario, Canada, I learned, Oct. 5, that there seemed to be no traces of the disease among the cabbage worms of his vicinity. Prof. Snow, of Topeka, Kansas, informed me, likewise, that it certainly had not appeared in that vicinity; and Mr. E. W. Doran, of Loudon, Tennessee, Assistant Entomologist of that State, reported to me, as late as October 19, that he was unable to detect any evidence of its occurrence there. In Iowa, however, I learned indirectly that it had appeared in the fields in the vicinity of Ames; but whether as a consequence of the gradual extension of the area occupied by it, or as a result of the experiments instituted for its propagation there the previous year, my informant was in doubt.

As no precise description of this affection has been published, as far as I am aware, I give herewith one soon to appear in an article on the Contagious Diseases of Insects, now in press in the Bulletin of the State Laboratory of Natural History.

In this insect *flacherie* is distinguishable with great ease and certainty by conspicuous external symptoms, the color alone of affected larvæ being, in fact, entirely characteristic and unmistakable. The natural color of a healthy cabbage worm is a light lively green, sometimes slightly tinged with yellowish, but without any approach to an ashy or milky hue. As the first symptom of *flacherie*, however, the larva commences to turn pale, this paleness increasing more or less rapidly until the color is almost milky white, only slightly tinged with greenish. This discoloration is uniform and simple, no other tint usually appearing until after death. Then,

however, the color deepens to a sooty gray, commonly uniform, but sometimes first appearing about the center of the length of the larva. Occasionally this deeper color appears a little before death, but it is not then of equal depth over the whole surface.

In the actions of the insect there is little to indicate any change of state, except a gradually increasing sluggishness, slowness of movement, and loss of appetite. These are later to appear than the pale discoloration above mentioned, and even shortly before death a larva may show considerable impatience if roughly handled. When the disease is well developed, the caterpillar is very feeble, and will remain motionless for a long time; or if it attempt to crawl where some strength is needed, as horizontally on a vertical surface, it may lose its hold with its jointed limbs and cling only by its central prolegs, the fore and hinder parts hanging limp and helpless at right angles to the remainder of the body.

Most commonly an escape of fluid from the vent is among the earlier symptoms of the affection, at first greenish or whitish, and later a dirty gray, or even a chocolate brown. Rarely this fluid exudes also from the mouth. The amount of it is usually sufficient to stain considerably the surfaces over which the larva crawls; but sometimes this symptom is wholly absent. Occasionally the intestine is found empty after death, but almost invariably it is well filled with food, much of which retains its native color, digestion being, in fact, evidently suspended during the course of the disease. I have found in only a single instance an appearance of bubbles of gas in the alimentary canal. Usually the mass of the alimentary contents seems to lie inert in the stomach, undergoing neither digestion nor decay.

The color of the fluids of the healthy larva is a very pale transparent green, the blood containing only lymphoid corpuscles in greater or lesser number; but if a proleg of a diseased specimen be snipped off, and a cover glass be pressed against the cut surface, the droplet exuding will be of almost milky whiteness, or, in the latest stages of the disease, a dirty gray. Rarely, where there has been much escape of fluid from the vent, the juices of the larva will be thick and scanty, so that it requires some pressure to force out a very small quantity. If a minute droplet of the milky fluid obtained by snipping off a proleg be examined under a high power of the microscope, it will be found to contain innumerable myriads of very minute spherules, varying in diameter, according to the individual, from .5 μ to 1 μ. Usually their average size does not surpass .7 μ. It is the infinite multitude of these which gives to the fluids of the diseased caterpillar their milky look, and, likewise, unquestionably it is they which cause the ashy appearance of the surface, the skin being thin and delicate, so that the color of the fluid contents shows through. The diseased blood is so thick with these minute corpuscles that little else can be ordinarily seen in it. Sometimes, however, degenerated lymphoid corpuscles of the blood will be noticed, recognizable by their size and spherical contour, but differing from the normal corpuscles in their darker tint and coarsely and irregularly granular structure. These darker, granular corpuscles are always dead, no longer exhibiting amœboid movement, and have usually a spherical form. Not infrequently

débris of the fatty bodies is apparent in the form of large irregular cells, floating freely in the fluid; but these cells themselves will be found to contain immense numbers of the minute spheres already mentioned. In fact, if a little portion of the soft remnant of the fatty bodies be removed, spread upon a cover, and examined with a power of a thousand diameters, it will be seen that the cells of these organs are the seat of an extreme degeneration, the entire contents of many of them being wholly replaced by the spherical granules mentioned above. Occasionally a cell containing a nucleus will be found, but more commonly all distinction of contents has disappeared.

If the body of a diseased larva be cut across and a cover glass be pressed against the cut end of the intestine, or, still better, if the larva be opened lengthwise, and the stomach removed and laid open separately, so that a droplet of the pure contents of the alimentary canal may be obtained, the fluid portion of these contents will be seen to swarm with infinitesimal granules similar in appearance to those found in the blood, except that they are, on an average, often appreciably larger and are occasionally more or less oval in outline. These same forms may also be found in the fluid excreta escaping from the vent of the still living larva. If the specimen has been dead some time, so that the sooty discoloration of the surface has occurred, the fluids both of the alimentary canal and of the body at large will often be found to contain, besides myriads of the above spherules, various other forms clearly recognizable as septic bacteria,—among these, members of the genus Bacterium, easily distinguishable by their oval form and by the manner in which they actively propel themselves across the field of the microscope. Rod-like bacilli may also appear in the fluids at this time, equally active, and evidently moving by means of flagella, especially in the vicinity of the bubbles of air which may be included in the fluid under the cover glass. Occasionally these latter bacterial forms may be found in smaller numbers even before death, very rarely in the perivisceral fluids, but not very uncommonly in the contents of the alimentary canal. Still they are infinitely less abundant than the Micrococcus-like spheres already mentioned, even long after the death of the larva.

The most characteristic *post mortem* phenomenon is the rapid softening, decay, and deliquescence of the body, the whole of which may be converted, in an hour or two after death, into a dirty fluid mass which the rotten skin is barely sufficient to hold together. This breaks at a touch, allowing the fluid contents to escape.

More recent studies of transverse sections of the bodies of diseased larvæ, prepared as microscope slides, have given me a number of additional interesting facts with respect to the pathological conditions of this disease, a brief account of which may with propriety be given here.

As determined by a study of the tissues of larvæ diseased but far from dead, the principal center of the affection was seen to be in the alimentary canal, the fatty bodies, and the blood. The mucous membrane of the pharynx, œsophagus, and rectum was but little

altered, but that of the chyliferous or digestive stomach was greatly disorganized. The inner ends of the long cylindrical cells with which the alimentary canal is here lined were always broken down, and much of the remainder was occupied by minute spherical granules, most of them, apparently, micrococci, this degeneration occasionally extending through nearly the whole depth of the epithelial layer. Sometimes, in fact, the basement membrane was almost denuded and the wall seemed upon the point of perforation; but no actual solution of the basement membrane and muscular coat of the stomach was noticed in any of the sections examined. The cells of the fatty bodies were commonly so far replaced by collections of finely granular matter, that the true structure of these bodies was almost indistinguishable. Applications of caustic potash to the sections, and consequent partial solution of the tissues, commonly showed, however, that this was due to an infiltration of these tissues rather than to a complete degradation of them. All the exposed surfaces of structures within the perivisceral cavity were usually covered with aggregations of the spherical granules characteristic of the disease, which often formed layers or masses 12 μ or 15 μ thick. These granules, not definitely distinguishable in the mass, partly owing to their dense aggregation, and partly, also, to their concealment by the coagulation of the blood, were, nevertheless, unmistakably the same as those swarming so thickly in the fluids of diseased larvæ while still living. I could not detect any especial degeneration of the nerve centers, or of the nerve tissues, or, in fact, of any of the other vital organs, with the occasional exception of the Malpighian tubules. The hypodermis, however, was sometimes more or less disorganized, probably in those parts of the body presenting a blackish discoloration during life. Over such areas the hypodermal cells were broken down, their structure lost and replaced by a granular detritus. In these sections, prepared from specimens kept for some months in alcohol, the spherical granules stain with great difficulty and readily decolorize.

In the course of a series of experiments performed upon the CODLING MOTH (*Carpocapsa pomonella*), this species received at our hands extraordinary attention in all its relations. An elaborate account of our observations respecting its life history and its susceptibility to remedial measures is given in another article, and I add here only facts showing the abundance of the species during the present season. Of nearly 10,000 apples examined from trees used as checks upon our experiments, and which, consequently, had not been treated with any insecticide, 59 per cent. had been infested by the codling moth,—a proportion doubtless unusually great, and due in part to the extraordinary scarcity of apples following a year of great abundance.

That dread enemy of the cereal crops, the notorious ARMY WORM, (*Heliophild unipuncta*) seems to be making head in southern Illinois, having evidently occurred in injurious numbers throughout all that part of the State from Bond and Wabash counties to Alexander and Gallatin. Our information concerning this species covers the counties of Alexander, Bond, Gallatin, Jackson, Perry, Wabash, Wayne, and White, in all of which this pest was injurious to pastures and meadows, and was occasionally reported to have made a visible impression upon the crop of corn in June. I do not hear of

any effort made by the farmers of that region to arrest its progress, either by the general application of poisons or by the older resource of ditching across the line of march and crushing the accumulations.

The LESSER APPLE LEAF ROLLER (*Teras malivorana*) is reported to have so intensified its injuries this season as almost completely to obstruct, in some localities, the business of growing young apple-trees for the market. At Normal, especially, in the grounds of the Home Nursery Company, the mischief worked on the susceptible varieties has been of a very discouraging character, and has even disposed the proprietors to transfer their apple business to a western state. Possibly, however, the trees would have withstood the attacks of this leaf roller if these had not been seconded by those of the green apple leaf hopper (*Empoa albopicta*), which, by sucking the sap from the leaves at the time the leaf roller is denuding them, more than doubles the final effect on the tree.

As a result of a short series of experiments made with kerosene emulsion and with lime, at Normal, I learned that no liquid or powdery application could reach a sufficient number of the larvæ secluded in the rolled and webbed leaves to make it at all worth using for its immediate effects. If, however, the young trees were occasionally sprayed with an arsenical poison, and especially if this treatment were begun rather early in the season, I have no doubt that perfect protection from this insect would be afforded. While the poison would be little likely to reach the larvæ rolled in their silken nests, it would nevertheless take effect as they extend their webs to cover fresh surface.

Concerning the ROOT WEB WORM (*Crambus zeëllus*, Fernald), seriously injurious to young corn in May and June, much additional information is still to be desired, and I report here the facts already made out, in the hope that other observers may thus be induced to assist in the completion of the life history of the species, and may help us to a fuller knowledge of its habits and of its injuries to vegetation.

Although working somewhat like the cutworms, it belongs to another family of moths (the Pyralidæ or snout moths), and may easily be distinguished from these pests by its habits and by the character of its injuries. If a hill of corn damaged by this insect be carefully examined, a mass of dirt, loosely webbed together, will invariably be found just beneath the surface of the ground, close beside the young stalk or among the larger roots. If the nest (irregular in shape, and commonly an inch or two in length) be opened, a reddish, bristly, active worm, half an inch, or a little more in length if full grown, will be found hidden within, the matted earth evidently serving as a retreat from danger.

The central part of the nest is commonly occupied by a silken tube, which extends more or less vertically downward into the earth, often opening at the surface close beside a stalk of corn, by a round orifice about the size of a wheat straw. This tube is commonly an inch and a half or two inches in length, and within it the worm may be found concealed. Sometimes the web lies horizontally, or nearly so, with its opening at the surface next the stalk, often with the web attached to the latter, or even fastened by

threads some distance above the root. Some webs are placed vertically, lying close beside the stem. They frequently occur under clods, and occasionally one was seen scarcely protected at all.

The injury to the corn is extremely characteristic, and cannot be mistaken when once understood. The web worm evidently leaves its burrow to feed upon the leaves, at first the lower one and then those nearer the top of the stalk, commonly eating off the ends of the leaves or gnawing irregular holes near the middle of the larger ones. The lower leaf of the infested plant is ordinarily eaten wholly away. Occasionally I have found a leaf cut off and drawn partly into the burrow of the worm; and sometimes the kernel of corn was eaten in the ground. The stalk of the affected plant will be found gnawed irregularly beneath the earth, sometimes wholly severed, as by a cutworm, but more commonly scarified, or bored lengthwise, either superficially or through the centre of the stalk. From one to eight or ten larvæ may be found in a single hill. In a field near Champaign, on land in pasture for fifteen years, plowed up about May 5 and planted to corn from five to ten days thereafter, I found the corn so badly injured by this insect that the owner had decided to replant the greater part of it. No difference in amount of injury could be correlated with difference in soil or surface, the worms being as abundant on low ground as on high, and as indifferent, seemingly, to character of soil.

Near Mount Pulaski, June 16, we found a field of corn which had been practically destroyed by this insect about two weeks before, and had consequently been plowed up and replanted. This field had been in pasture for a number of years and was broken up for the first time the preceding fall. The web worms had not, apparently, been seriously disturbed by the replanting, but had already attacked the young corn of the second growth, and to this were doing considerable damage.

As the larvæ in the Champaign field were, several of them, full grown, and the greater part of them nearly so, it is certain that the eggs were laid in the sod before it was broken up. The root web worm consequently breeds in grass. This view is confirmed by information concerning this insect from J. P. Norton, of Libertyville, Lake county. A field of twenty acres, plowed up from greensward in spring and planted to corn, was said by him to have been immediately cut down by the root web worm as it came up, and the webbed larva was found, in each case, just below the surface, about the roots of the corn, not missing, according to his report, a single hill. On the other hand, Mr. R. S. Mills, of Dwight, Illinois, (in whose field I first studied the species, two years ago,) writes me that the ground upon which the corn was injured had been alternately in corn and oats for six preceding years, and for three or four years before that, in corn.

The species was sent us last year from various localities in Henry, McLean, Mason, and Livingston counties, and doubtless occurs everywhere throughout central Illinois. From the Crop Reports of the State Department of Agriculture, I learn that this insect, a description of which had been but recently published, was noted by the crop reporters of the Department in Carroll, Cass, Stark, and

Livingston counties, and in Henry county in June. It is not altogether certain, however, that the insect referred to by these correspondents was in all cases the species here under consideration.

I base a surmise of the occurrence of this pest in Rock Island county upon a report received by my assistant, Mr. Hunt, from two farmers near Milan. They had noticed a worm making a web at the roots of the corn and eating the leaves while young, afterwards working at the roots, often cutting the corn off just below the surface of the ground. Several acres of sod corn were completely destroyed by these insects, only here and there a hill being left. As I know of no other corn larva which constructs a web in the earth at the roots of the plant, it seems highly probable that our species is here indicated—possibly confused also with some cutworm attacking the corn at the same time.

Our first specimens were taken May 19, at which time many of them were only about half grown. In our breeding cages, the larvæ changed to pupæ in the earth at some time during the latter half of June, and the adult moths emerged from the 1st to the 22d of July. The average size of the larvæ in the Champaign field leads me to doubt whether it is possible that they can have resulted from eggs laid in the spring, especially as diligent collecting from the first opening of the season did not yield us a single moth of the species from which these worms descend. The brood observed by us must have practically completed its development before the end of July. Whether a second brood occurs or not, is wholly uncertain, and to this point especial attention is asked of those at work in fields of corn throughout the summer.

The root web worm is of a pale reddish brown color, without stripes, and marked only by rather large shining dark spots, each bearing a long black hair. The head is dark chocolate brown, with a few long yellowish hairs. Upon the front is a Y-shaped white mark, which does not coincide with the sutures of this region, the branches of the Y lying some distance outside the corresponding sutures, and the common stem being relatively short. The top of the first segment behind the head is yellowish, with a white median line, whitish anterior edge, and an oval black spot on the sides, near the middle of the lateral margin. Surface with a few scattered long dark hairs. The second and third segments bear two rows of piliferous spots, the anterior consisting of four large square spaces, the posterior of two, sometimes united with each other. From the fourth to the tenth segment these spots are in two transverse rows of four each, those of the front row being nearly square and at least as large as the spaces between them, and those of the hind row transverse, elongated, about twice as long as wide. Directly before and outside of each proleg is a narrow, curved, shining tubercle bearing several long hairs. The breathing pores are all dark brown, the anterior one the larger, and the two posterior next in size. The under surface of the worm is a little paler than the upper. Length of a full-grown specimen, .6 inch; its greatest width, .1 inch.

The chrysalis or pupa is smooth, shining pale brown, the abdomen a little darker, without hairs or spines. The eyes are reddish brown, head bilobed above. The abdomen has a blunt horny tip. Length, .4 inch; breadth, .1 inch.

The moth measures across the wing .75 inch to an inch. Head and thorax are pale leaden gray. Two feelers, the labial palpi, extend forward in front of the head a distance equal to the length of the head and thorax taken together. The fore wings are a dull leaden gray, mixed with ashy and white, especially on the outer pair, and crossed outside the middle by two angulated, dull ochre-yellow lines more or less overlaid with dark brown. The line bordering the wing is dark brown, and a brownish cloud extends obliquely in from near the front outer angle of the wing to the second transverse line. A narrow ochre-yellow line, somewhat curved, extends from the middle of the base of the wing to the second line near the anal angle. The outer margin of the wing is regularly excavated below the apex; fringes pale metallic lead color. Hind wings smoky, with lighter fringes; underside of the body and all the wings pale dusky.

Minute mites, which attacked the pupæ in our breeding cages, and were apparently responsible for the loss of nearly all the larvæ we attempted to rear, probably also attack the worm in the field. At Champaign, an undergrown example was found, May 28, infested by this mite, a number of which were running freely over the surface of the larva.

Besides this, I determined by dissection that certain predaceous beetles, especially abundant in fields infested by the web worms, had also been feeding upon them. Further than this we have no knowledge of natural checks upon the increase of the species.

The injuries inflicted occur so early as to permit a replanting in most seasons in case they should be of serious import, and this species is consequently to be classed with the cutworms so far as the effect of its injuries to corn are concerned.

If the corn is to be replanted, advantage should be taken of the fact that all the larvæ are collected in the old hills of corn remaining from the first planting. If the usual practice is followed by plowing up the old corn as soon as the new is planted, these larvæ will of course immediately resort to the sprouting grain and continue their mischief there; whereas, if the old corn be left as late as consistent with the proper cultivation of the crop, the new planting will probably secure a sufficient start to escape serious injury. The web worm matures from the middle of June to the first of July, and then ceases its mischief, so that a little delay in plowing up the old corn may save the new.

It is easy to dislodge these larvæ without injury to the corn, since their presence may be detected by the peculiar appearance of the plant, and the worms themselves are secreted within an inch or less of the surface, close about the stalk attacked. By passing the finger around such stalks, the larvæ may be readily unearthed. Where badly infested fields are not too large, and the help of a boy or two is available, I do not doubt that it will pay to capture the worms in this manner.

As a mere beginning with remedial experiment I directed, early in June, some applications of the kerosene emulsion to larvæ of this insect enclosed in small boxes of earth, each containing about eight cubic inches. Repeated applications of one dram of

kerosene emulsion poured upon the surface of the earth was invariably fatal to the enclosed worms. (The emulsion was composed of suds, one pound of soap to ten gallons of water, churned with an equal quantity of kerosene. The amount of kerosene used was consequently one half a dram.)

In the "Country Gentleman" for May 30, 1872, I find an interesting note from a subscriber living in Queens county, New York, which it seems to me may possibly relate to the root web worm:

"Yesterday," he says, "I was surprised to find that the young corn had almost entirely disappeared, and upon examination of the hills worms like the specimen sent herewith were found just beneath the surface of the ground, that had evidently worked the destruction of the growing crop. From one to five or six were found in proximity to a hill. They are enveloped in a web, and have the faculty, when detached from it, to spring somewhat after the manner of the worms often found in cheese.

"Their method of destruction appears to be in eating the young shoot just under the surface of the ground, until it falls over and dies, after which they gnaw the stumps downward toward the kernel, thereby probably preventing the plant from shooting out again, as it does after the ravages of the worm known as the cut or black worm.

"The field in which the corn is planted was a sward, but the grass last summer on it appeared to be dead; whether the same insect or worm caused that, I do not know."

The Hessian fly (*Cecidomyia destructor*, Say) has continued during the last year its career of devastation in southern Illinois with a very unusual persistence. As a general rule, a year of extraordinary abundance of this insect is followed by one of immunity from its ravages; but for three successive years in the counties of Fayette, Effingham, and Clay, the Hessian fly has abounded in numbers to prevent the harvesting of many fields of wheat, and to inflict very serious injury upon many more As a consequence, last autumn, I heard seriously debated the advisability of general abandonment, throughout the infested region, of the cultivation of wheat until the Hessian fly had disappeared.

From our own observations and collections of the last three years, and from information contributed by very intelligent correspondents who have spent years in the midst of the Hessian fly, I infer the strong probability of two important items in the life history of the species: (1) the emergence as imagos, before harvest, of a great part of the larvæ found in the wheat in May; (2) the development of an additional brood in volunteer wheat, the flies of which appear in autumn early enough to deposit their eggs and produce a third brood of larvæ before the advent of winter. These facts suggest the possibility of greatly checking, if not practically arresting, the multiplication of the Hessian fly in our latitude by the following simple procedure: According to the best agricultural practice, the stubble is plowed for wheat immediately after harvest. In case there has been little or no shelling out of the grain in the field, a little may be sown before plowing, so that enough may grow, either of volunteer

wheat or of that from this sowing, to tempt all the flies then abroad to deposit their eggs early in the season. Previous to sowing the wheat for a crop (and this may now be done early to advantage), this young wheat should of course be killed by a rotary harrow or some similar instrument, in which case, if this action be intelligently timed, all the young or half-grown larvæ in this growing grain will of course be destroyed. If such procedure were general throughout a neighborhood, there seems very good reason to suppose that a vast number of the flies must be destroyed, only those remaining which had not emerged in time to deposit their eggs before this final sowing of the fields—a percentage probably too small to do serious mischief.

My information is also to the effect that wheat sown in the latter part of August is often much less liable, in southern Illinois, to be seriously damaged by the fly than late sown fields. In the early sown grain the larvæ transform and the flies emerge before winter, the wheat having time, before its growth is arrested by the season's cold, to rally, by tillering, against the damage done. Late sown wheat, on the other hand, if attacked by the fly, is certain to be seriously damaged, because it has no opportunity to recuperate, and whether attacked by the fly or not, is extremely likely to be killed by the winter. It is not an uncommon thing in southern Illinois, in seasons not especially remarkable for severity, for fifty per cent. or more of the winter wheat to be winter-killed as a consequence of the late date at which it was sown, in the hope of protecting it against the dreaded fly.

Since my article on the Parasites of the Hessian Fly, in my Entomological Report for 1884, another on the same subject has been published by Dr. Riley in the Proceedings of the United States National Museum for 1885. In this paper the parasitism of *Eupelmus allyni* upon the Hessian fly, implied in my own Report, is positively asserted; a new species of parasite, *Tetrastichus productus*, is described and treated; and the species described by myself, under the name of *Pteromalus ? fulvipes*, is described by Dr. Riley as *Merisus subapterus*. As he had both winged and wingless specimens of the species, his generic identification is probably correct. I had seen only the latter form, and consequently did not attempt to positively fix the genus of the species, described. As my description antedates that of Riley by some weeks, the name of the species must stand *Merisus fulvipes*, Forbes.*

The CLOVER SEED MIDGE (*Cecidomyia leguminicola*, Lintner), first described by Lintner as *Cecidomyia trifolii*, in 1879, (the present name being afterwards substituted for the above) was first reported in Illinois, as far as I can learn, by W. F. Carpenter, of Steward, Lee county, in 1882, in a note to the "Prairie Farmer," the date of which I have not at hand; but in a recent letter Mr. Carpenter informs us that he first observed the pest in Illinois in 1878 or 1879, and that it kept increasing in his locality from year to year

*As the generic identification of the species described by me under the name of *Pteromalus pallipes* has been called in question by the editor of "*Entomologica Americana*" (upon what ground it is impossible for me to imagine), it is proper to say that the species in question belongs strictly to the genus Pteromalus, as limited by Thompson in his "*Hymenoptera Scandinaviæ*," but not to any of the subgenera recognized by him.

so that the crop had not been worth saving. As it was first observed by Lintner in New York in 1877, it is difficult to say whether this was originally an Eastern or Western species, or whether it may not have secretly pursued a less offensive course for some years in various parts of the country. In northern Illinois it has been especially injurious this year, notice of its ravages coming to the office from the Farmers' Club of Marengo, in October. From some infested clover heads obtained through the Secretary of the Club, N. J. Wheeler, we had the good fortune to breed five specimens of a new parasite enemy of this midge,—a chalcid belonging to the genus Tetrastichus, and apparently of a species undescribed. Previous to this, two species of parasites have been reported as preying on it,—*Eurytoma funebris*, Haw., and *Platygaster error*, Fitch. Additional insect enemies were detected in our breeding cages,—one of them a small heteropter, so abundant everywhere that it may well serve a useful purpose in lessening the numbers of this clover pest. The facts concerning this insect were well worked out by my assistant, C. M. Weed, and I give them as reported in his notes. Finding in the breeding cage some larval specimens of *Triphleps insidiosus*, Mr. Weed isolated one of them with a larva of the seed midge in a small glass dish October 10, and found the larva dead, with shriveled skin, on the morning of the 12th. Another larva was then imprisoned with the bug, and this the latter immediately attacked. "As soon as the bug felt of it with his antennæ he pierced the skin with his beak. The larva struggled violently for about twenty seconds, but the bug did not let go, avoiding the body of the writhing larva by constantly retreating. At the end of twenty seconds, the larva ceased all motion and appeared perfectly dead. May it not be that a poison was ejected from the beak of the bug? For six minutes the bug continued sucking the body juices without removing his beak from the place where it was inserted (about the middle of the body), but he soon withdrew it and inserted it again near the middle, where it remained for nine minutes, when it was again changed to a place still nearer the middle. Eight minutes later the beak was again withdrawn and inserted near the head, where the bug continued vigorously sucking for six minutes, when it seemed to have enough. Thus he was sucking his victim about twenty-nine minutes."

Further, Mr. Weed determined the interesting fact that this midge is likewise possibly subject to the attack of a small caterpillar which he found lurking in one of the heads of clover. As the larva was seen to feed on the midge mite only in confinement (under which circumstances many lepidopterous larvæ become carnivorous), and as it was not preserved in condition for successful study, the particulars of the observation are not reported.

The WHEAT BULB WORM (*Meromyza americana*), which has been mentioned in my two preceding Reports, has scarcely come to our notice during the past year, but an item of information recently obtained from Mr. J. J. Nussbaumer, of Okawville, Washington county, is of such economic interest as to be well worthy of record. The wheat of that vicinity was last year badly damaged, as supposed, by the Hessian fly, but Mr. Nussbaumer tells me that, examining

plants in damaged fields in early spring, he found, not the brown flaxseeds of the Hessian fly, well known to every one, but pale watery larvæ between the bases of the leaves just above the root, corresponding closely, according to his description, to the larvæ of *Meromyza americana*, treated in my previous reports under the popular name of the "wheat bulb worm." It is consequently en irely possible that locally, in southern Illinois, the damage to wheat, attributed to the Hessian fly, is really due to this insect.

The common WIREWORMS (larvæ of Elateridæ) have been neither more nor less destructive than usual in corn fields, during the past season. The fact was repeatedly noticed that in fields two years from sod, injury to corn was much more evident than the year preceding, or in other fields of the same vicinity in sod one year ago. This fact is doubtless to be attributed to the death of the grass in the sod the second year, and the consequent concentration on the corn of all the wireworms in the field. Corn on sod was destroyed by the wireworms the first year on the farm of Mr. E. A. Chester, near Champaign, but the ground had been used during the fall, winter, and spring, as a feed lot for cattle and sheep, so that the sod had been nearly destroyed. In a field near Champaign, more than half of which had been destroyed by wireworms, (the whole field being as a consequence plowed up and replanted) a prolonged search failed to discover a single wireworm, except in the hills of corn,—in each of which from two or three to six or eight were present. The impropriety of the common practice of replanting is obvious. By planting between the rows of young corn and plowing up the latter at once, the wireworms are scattered and their food destroyed, and they are forced to attack the new corn just planted; whereas, if this were allowed to get a start before the corn of the first planting was plowed up, the probabilities of loss would be greatly lessened.

For the purpose of determining more precisely the life history and the species of the wireworms affecting our corn, breeding experiments were begun this season. From over one hundred larvæ, obtained May 25, and placed in boxes of earth mixed with soaked corn and covered with sod, we obtained a considerable number of imagos, all belonging to the species *Melanotus cribulosus* as determined for me by Dr. Horn, except a single specimen of the better known species, *Melanotus communis*. When the breeding boxes were examined on the 12th of July no pupæ were found, but by August 8 transformations had begun. On the 22d of August pupæ were seen, but no imagos. On the 12th of September fully developed imagos, just transformed, were dug out of the earth. No imagos appeared above ground during fall and winter, although living individuals were removed from the pupal cells in the earth as late as November. It is evident, therefore, that *cribulosus* (and probably *communis* also) completes its larval life during the latter part of summer; that it pupates in cells in the earth; commences to transform to the imago in early autumn; and remains under ground for hibernation.

In fields of sod corn near Peru, Illinois, I found, as late as July 1, 1883, many wireworms devouring the roots of corn and penetrating the stems just above the root, about six per cent. of the stalks in one of the fields having been killed in this way. Sometimes two or three of these larvæ were found boring through a single stem. The wireworms here collected agree in every particular with those described in the Canadian Entomologist, by Dr. Horn, the beetles bred from which were identified by him as *Agriotes mancus.** This species is readily distinguished from Melanotus by the cylindrical, blunt terminal segment, marked above by a large black circular pore upon each side of the base. In this same field occurred the wireworm doubtfully identified by Dr. Fitch as our common *Melanotus communis*,†—an identification which I am very much inclined to consider correct because, as noticed above, we bred this species, last year, from corn wireworms.

Believing it to be quite within the limits of a reasonable probability that apparatus may be invented for the rapid and economical application of insecticides to hills of growing corn, I instituted, last June, some experiments upon wireworms with a view to determining what insecticides, if any, would be effective against them. Placing individual larvæ in boxes containing fifteen cubic inches of earth, a dram of kerosene emulsion (half kerosene) was poured over the earth without effect upon the larvæ. A repetition of this experiment gave the same result, but a dram of pure kerosene applied in this manner promptly killed the wireworms. Pyrethrum thoroughly applied directly to the wireworms seemingly did them no harm. Sprouting corn treated with water containing suspended Paris green was not attacked by wireworms placed in the earth with it, but neither were the latter themselves injured. Sprouting corn placed in earth with which Paris green had been mixed failed to grow, but was not attacked by the wireworms, these remaining alive and active.

To determine the effect of treating seed corn with arsenic previous to planting, moistened kernels were rolled in powdered arsenic and allowed to dry, others at the same time being dampened with water holding Paris green in suspension. Only three kernels, out of a possible one hundred, grew in the first lot and two in the second, as compared with the check corn planted at the same time. Later a hundred grains of corn moistened with water and rolled in a mixture of Paris green and plaster of Paris—one part to fifty—were planted in comparison with another hundred grains not so treated, both lots of corn being planted in separate boxes and similarly treated. Forty-four kernels grew in the poisoned boxes, and forty-eight in the check, both lots appearing above ground simultaneously and growing for a month together without important difference.

From the foregoing we may infer the practical inefficiency of both pyrethrum and kerosene emulsion as a protection against these insects, and the doubtful efficiency of Paris green. This last deserves, however, further experiment.

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* Canadian Entomologist, Vol. IV, p. 3.

† Trans. N. Y. St. Agricultural Soc., 1846, p. 529.

The occurrence of wireworms in wheat in numbers sufficient to attract the attention of the farmers has been reported from Washington county by Mr. J. J. Nussbaumer. The specimens sent by him from wheat fields are of a different species from that infesting the corn at Champaign,—one of which we have bred none to the imago, and which consequently cannot be specifically determined.

Five or six acres of wheat were completely destroyed in one field, the plant being eaten off just above the root; and Mr. Nussbaumer estimated that throughout that entire neighborhood an average of one acre in forty had been so destroyed.

The very common BLISTER BEETLES (*Meloidæ*) were far more abundant this year than usual,—a fact doubtless to be connected with the extraordinary abundance of grasshoppers, upon the eggs of which their larvæ are well known to feed. The species most frequently mentioned in our notes of injuries to crops are the so-called "old-fashioned potato beetle," or striped blister beetle (*Epicauta vittata*), the margined blister beetle (*Epicauta cinerea*), and the common black blister beetle (*Epicauta pennsylvanica*). The last is yearly abundant, feeding in autumn upon the flowers of the golden rod and other composite plants; but the other two species are more variable in their numbers. The abundance of *Epicauta pennsylvanica* was noticed as early as the 4th of July, at which time we found it feeding upon the leaves of the honey locust. In August, it was very common in corn fields, associated with the two other species, all of which were feeding freely upon the fresh silk of corn, doing thus apparently a very considerable mischief by preventing the fertilization of the kernels, and partially blighting the ear. Rarely, also, we saw the black species eating the kernels at the top of the ear. The striped blister beetle, likewise common in corn, was more abundant upon potatoes and tomatoes, often stripping these plants of their leaves. The margined blister beetle was also noticed in July and August feeding upon potatoes and tomatoes, sometimes more abundant than the striped species. In corn fields it attacks an allied weed, the common ground cherry (*Physalis viscosa*).

The CORN ROOT WORM (*Diabrotica longicornis*) seems certainly no less abundant than heretofore, although farmers who have adopted the practice of frequent rotation are rarely subject to its injuries.

An extension of the injury of this insect to other crops than corn was inferred by me from the abundance of the species in a field of Indian corn, near Champaign, with the following history. After several years in corn and sorghum, alternating at varying intervals, this field had been planted to sorghum in the spring, following a crop of sorghum. The planting failed, however, and the ground was replanted to corn for fodder, which was fed down by stock in the fall. Following this the field was again planted to corn last spring, and in July I found there abundant evidence of the presence of the corn root worm, in numbers sufficient to produce a very considerable injury to the crop.

Early in September, an assistant, Mr. Hunt, visited a broom-corn field near Champaign, which had produced only about half the

usual crop, this field having been in broom corn for 12 or 13 years. The condition of the roots was precisely that produced by the corn root worm, although at that late date none of the larvæ were to be found in the ground. No facts have as yet come to my knowledge which indicate that diversities of season have any appreciable influence upon the numbers or activity of this insect, though during seasons favorable to the growth of the corn, less damage is, of course, perceptible.

I feel bound to do my best to excite the serious apprehension of farmers respecting the future of the corn root worm in regions where it is being neglected. I have no doubt that under such circumstances, multiplying continuously as it is liable to do, it will in time accumulate in such numbers as no longer to confine its chief injuries to fields principally in corn, but that the beetles will be early forced to scatter, in search of food, from the fields in which they emerged, and that the eggs will consequently be freely laid everywhere in the ground instead of being confined, as now, chiefly to corn fields. Indeed, there is already some serious indication of the approach of this calamity. From Mr. B. C. Davis, of French Grove, in Peoria county, I learned this fall that the adult beetle has been seen in his vicinity, flying in swarms, so early in the season that it is not at all likely that the females had yet deposited the principal part of their eggs. In such cases the ground will almost certainly be heavily stocked with the eggs wherever a sufficient food supply occurs, and fields not lately in corn will be liable to show next year evidences of serious injury by this pest. As the beetle lives largely upon the pollen of plants, and congregates upon clover heads and other late blooming flowers, it is in fields of clover, or those containing an unusual amount of fresh young vegetation, that this prevalence of the corn root worm is likely to be noticed.

It is not unlikely that the abundance of grasshoppers in corn fields in some parts of the State this autumn, and the consequent diminution of the ordinary food supply of the corn root worm beetle, may have forced it to leave the corn fields earlier than is its custom. But this consideration serves to enforce the importance of a general and frequent rotation of crops as a safeguard against a pest so liable to take advantage of even slightly favoring circumstances, and to inflict uncontrollable damage upon the principal farm crop of the State.

As a very effective precaution against a possible injury to corn by the root worm on ground not last in corn, I would suggest the early fall plowing of such fields. By thus destroying the food of the adult before the season for the laying of the eggs, all temptation to resort to these fields will be removed. To this end, ground in clover, or that covered with any sort of late blooming vegetation, or with a fresh growth of tender herbage, like volunteer oats, should be plowed before the middle of October, if intended for corn.

The ravages of this insect are, so far, curiously limited to northern and central Illinois. Near Edgewood, in Effingham county, I failed to find any evidence whatever, either in corn fields or upon thistle blossoms, of the presence of this insect as late as September 12, at which time the beetle was superabundant as far south as

Champaign. In Union county, also, most careful search in cornfields and in other proper situations, has failed to give us the slightest evidence of the presence of this species. I think it scarcely likely that this immunity of our southern corn fields is due to any geographical limitation upon the spread of the species, since it was first described from Arkansas, was first reported as a corn insect from St. Louis county, Missouri, and has been frequently mentioned as very abundant in central Kansas. In a note of twenty years ago to Mr. Walsh, Prof. W. S. Robertson, of Kansas, reported the occurrence of this insect in very large numbers upon sorghum, its usual home being a large thistle. In his comments upon this information, printed in the "Practical Entomologist" for October, 1866, Mr. Walsh remarks that he took three specimens of this species many years ago, on flowers in central Illinois. Its rarity at that time, in the experience of so active a collector as Mr. Walsh, is evidence that this species is a somewhat recent enemy of corn in Illinois. It probably invaded the State from the westward, having its original home on the great plains, whence we received also its more notorious ally, the Colorado potato beetle.

From an observation first reported to me by a correspondent of the office, Mr. Benjamin Buckman, of Farmingdale, Ill., we derived an interesting item relating to the life history and habits of *Epicærus imbricatus*,—a snout beetle occurring very commonly in miscellaneous collections and also often encountered in my studies of the food of birds. These specimens, taken May 29, were charged by Mr. Buckman with eating the leaves of young pear trees. "They come up out of the ground," he says, "and may be seen with their heads just sticking out as if the earth had not been broken above them, while others have holes to which they seem to retreat, like a spider." The beetles were sent me in a box with a twig of pear, and when received several of the leaves were found stuck together by their opposed surfaces, with a closely packed layer of slender white eggs between them. To make sure that these were the eggs of the Epicærus, the beetles were removed to another box June 1, and confined with a fresh twig of pear. They were found two or three days afterwards, to have laid eggs upon the leaves and then to have gummed the latter together as above described. The edges of many of the leaves were also eaten. In an attempt to secure the hatching of the eggs, these were unfortunately left until they spoiled.

On page 183 of Mr. Saunders' valuable work on "Insects Injurious to Fruits," occurs one of the very few inaccurate statements which I have noticed in this book. Speaking of the PLUM CURCULIO (*Conotrachelus nenuphar*) he says that it occasionally deposits its eggs in the pear and apple, but that in these fruits *it seldom matures*. Finding, in 1884, that a large orchard of the present Secretary of the State Horticultural Society of Illinois, A. C. Hammond, Esq., at Warsaw, was badly infested by curculios, I collected about half a bushel of apples from which the imagos had not as yet emerged, and, placing them in breeding cages at Normal, I finally obtained a considerable number of adults of the plum curculio,—how many, I find our notes do not clearly state. During experiments made in

the apple orchard this season for the destruction of the codling moth, we found the plum curculio nearly half as prevalent as the other insect. It is, in fact, everywhere in apple orchards, far more common than the apple curculio itself in regions where no peach-tree has been seen for years, and even the plum is very rare. That it has been thoroughly habituated to the apple as its breeding place can no longer be considered as doubtful. Indeed, a statement to this effect was made by Mr. Walsh as early as 1867*.

Similar information is conveyed in a note from Mr. S. T. Maynard, of Massachusetts, published in the Report of the Secretary of the Board of Agriculture of that State for 1884. "It has often been noticed early in the summer," he says, "that apples nearly all fall from the trees when quite small. This was especially the case during the past season, and a careful investigation was made to ascertain the cause. A tree of the variety known as the Westfield Seek-no-further, which blossomed very abundantly and set an unusually large crop of fruit, was selected. When from one-half to one inch in diameter, the fruit began to drop in large numbers, so that not enough was left on the tree for half a crop. A large quantity of them were collected and examined, and out of eight hundred it was found that all but three were punctured by the plum curculio, leaving its peculiar crescent-shaped mark, and in every puncture was found an egg or small larva. The worms commonly found in the apple at this time have generally been supposed to be the larvæ of the codling moth (*Carpocapsa pomonella*), yet in the number examined only four or five of the larvæ of the latter were found."

Digging in an old pasture near Normal, June 13, 1883, I observed some thick footless coleopterous larvæ apparently feeding upon the thick roots of grass. They were not at all abundant, and our attempt to rear these specimens failed. On the 13th of July, 1885, I received from Mr. J. R. Gaston, of Normal, a number of specimens of what was evidently the same larva, taken by him from the roots of timothy in a field which had been about eight years in grass. The crowns of the grass were here eaten out, from one-half to one per cent. of the stalks being consequently killed. The same species was found in timothy at Champaign, about the middle of July, eating directly into the crown of the grass from beneath, usually throwing out a mealy mass by which the position of the larvæ could be recognized. On the 21st of July the grubs transferred to our breeding cages were still active and feeding upon the grass, but September 24 an examination of the earth discovered a living *Sphenophorus parvulus* associated with a larval skin and an empty pupa case, in a way to indicate beyond all question its connection with the footless larva under observation. October 5 another specimen of the same species emerged.

The larva of this species is a thick fleshy grub, white except the head, which is reddish brown with black mandibles. The body is much wrinkled, both transversely and longitudinally, destitute of feet, provided with a few scattered straight brown hairs, somewhat

*"I have found its larvæ very abundant in the cherries in Kankakee, and have this year bred it from numbers of the Early Harvest apple taken from Mr. G. H. Baker's orchard." Trans. Ill. St. Hort. Soc. 1867, p. 114. See also American Entomologist, Vol. II, p. 276.

longest at the tip of the abdomen. The cervical shield or dorsal part of the first segment is concolorous with the rest of the body. The sutures of the front of the head are obscure except the median one, which extends about half way to the epistoma.

An imago of this species was seen June 7, 1884, with its beak inserted in a stalk of wheat, and another was taken May 26, 1885, making an identical attack upon a young corn plant. So intent was it on its employment that it remained attached after the stalk was pulled up, and even then had to be forcibly pulled away. *Sphenophorus pertinax* was also found at the base of a hill of corn, June 16.

Although in our own observation (confined to the northern half of central Illinois) the CHINCH BUG has not anywhere appeared in sufficient abundance to threaten immediate injury, reports of correspondents of the State Department of Agriculture from the region immediately to the southward, give more unfavorable indications, and it seems extremely likely that unless unfavorable weather should interpose a check upon the rapid multiplication of this species, it may overpass the limit of insignificance before another year. In the August Crop Report the chinch bug was reported injurious to corn in Clinton, Jefferson, Macoupin, Madison, Pike, Wayne, White, and Richland counties,—in Pike, especially, the corn having been greatly damaged. As early as July, in fact, notes of injury to corn by the chinch bug were sent from Crawford and Madison counties.

I have already made mention, in a brief note relating to the lesser apple leaf roller, of the simultaneous and similar injuries done to the foliage of the young apple by the GREEN APPLE LEAF HOPPER (*Empoa albopicta*, Forbes.)* This species was described by me as a new apple insect in my Second Report (1883), and it was not until after this had been published that I happened upon a much earlier account of it printed in the "Prairie Farmer," of Chicago, for September, 1853. Dr. Le Baron, subsequently State Entomologist of Illinois, writes of this insect, associated then, as now, with an apple leaf roller, evidently the same as that which he afterward describes as *Teras malivorana*. "Every one," he says, "who has had the care of apple-trees in this section of country, and especially of young trees in the nursery, must have observed that during midsummer the newly formed leaves often become crumpled and rolled downwards, thus checking the growth of the tree for a time. Upon examining the under side of the leaves, the mischief is found to be caused by a number of small green leaping insects which belong to the tribe of Tettigonians, or leaf hoppers. They subsist upon the sap circulating in the leaves, which they obtain by puncturing the veins on the under side, thus causing them to roll downwards. These little insects are not stationary like the Aphides

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* A comparison of my specimens with an analysis of the genera of Jassidæ, given by Fieber, shows that most of the specimens clearly belong to his genus Chloria, although the outer apical cells at the tip of the hemelytra may be either sessile or stalked, partaking consequently of the characters of both his genera Chloria and Kybos. The head and pronotal characters are, however, those of Chloria. On the other hand, there can be no doubt that the species belongs clearly under the species Empoa, as described by Fitch, or under the genus Empoasca of Walsh. (Proceedings of Boston Society of Natural History, Vol. IX, p. 315.) As both these generic descriptions antedate those of Fieber, his genus Chloria must be considered a synonym.

and Coccides, but move readily by leaping, as their name implies, and, like most other insects, acquire wings and the power of flight in the last or perfect stage of their existence.

"I have never known them to multiply to a sufficient extent to do very serious injury. Besides, they appear to feed but little after their change from the pupa to the winged state, which takes place previous to the second or autumnal growth of the trees."

In another paragraph he gives a recognizable description of the species, and proposes for it the name of *Tettigonia mali*, or apple-ree leaf hopper. Curiously, no subsequent mention was made of this insect, either in his own writings or anywhere in the works of entomologists, previous to that in my own report. Although the specific name *mali* was the first proposed for this species, names based upon descriptions published in agricultural papers are not accepted by entomologists, and consequently, to avoid the perpetuation of a synonym, it is probably best to continue the species under the name given in my Report.

The serious character of the injury to the apple done by this insect, is sufficiently indicated in the note above on the lesser apple-leaf roller.

The life history of the species is not yet fully determined, although our observations amount to highly probable proof that it does not differ from the life history of the common leaf hoppers; that of the grape, for example, (*Erythroneura vitis*). Our earliest specimens were collected May 21, on clover, and repeated collections made thereafter in May and June, were all adults. By the 2d of July, however, both larvæ and pupæ appeared in the specimens collected from the young apple. Later in summer only imagos were found. From these data we may reasonably infer that the species hibernates in the adult condition, lays its eggs in early summer on the leaves of the apple, lives as an immature insect upon that plant, and completes its transformations to the winged stage in the latter part of summer and early autumn.

As an adult it is not by any means confined to the apple for food, but occurs upon a great variety of plants, being in fact a very common object in miscellaneous collections obtained by sweeping and beating. Clearly, the injuries of this species can be met only in spring and early summer, when the eggs and newly hatched young are upon the leaves. Dipping the tops of the trees at that time in an emulsion of kerosene, or possibly thoroughly spraying the nursery stock with this fluid, is, in my opinion, the most promising method of procedure.

This is not one of the nursery insects likely to be spread by shipments of young trees, since these are made in early spring, before it is at all likely that the imagos have laid their eggs.

What the Hessian fly is to wheat, that the CORN PLANT LOUSE (*Aphis maidis*) bids fair to become to corn. This species has been known in a general way for years, since it was first described by Fitch, but its life history (far from complete, it is true,) gives us as yet no clue to a method of combating its injuries. Even the hope which I have hitherto indulged, that it would be found most prevalent upon

ground which had previously been in corn, and that its injuries could consequently be arrested by judicious rotation, seems doubtful in the light of our recent experience.

Early in July, this season, reports reached me from the country surrounding Champaign, of a severe and mysterious injury to corn. This condition of affairs was discovered in eight adjacent fields, the areas affected varying from one third to four fifths of the separate fields. The injury, from all the attendant circumstances, seemed to me to be almost certainly due to plant lice. No great numbers were in the ground at the time, but concurrent testimony to their abundance on the roots a few days previously, was too weighty to be ignored, two intelligent farmers reporting that the plant lice had emerged from the ground in very large numbers, and scattered just before my visit to the fields.

The notorious SOFT MAPLE BARK LOUSE (*Pulvinaria innumerabilis*), which so seriously injured soft maple trees last year, seemed to the casual observer, in spring, to threaten an equal injury this season; but upon close inspection late in June, the cottony egg masses of the female were found, in nearly every instance examined, to harbor a coccinellid larvæ (Hyperaspis), by which the eggs were being rapidly devoured; and before the end of the season the pest was reduced to insignificance throughout the greater part of the area infested by it. In here and there a locality where it had been less abundant than usual last year, it reached its climax this, but the total damage done was slight.

The winter wheat near Champaign was last year very badly damaged by spring frosts, but late in April I learned of injury to a few fields, of such a character that the owners could not attribute it to the weather. In these fields great numbers of a small EARTH-WORM (Lumbriculus) were found collected about the roots of the dead plants, occurring also to some extent among the living wheat, but far less abundantly. To the presence of these worms some of the farmers attributed the damage done, and the question consequently arose whether these worms might not rather have been attracted to the wheat after the death of the plants, finding in the dead and half-decayed vegetation an abundance of food. To determine this matter we planted two small boxes of wheat, stocking one of them with 160 worms and leaving the other free. The wheat grew freely in both boxes and was entirely uninjured by the worms during several weeks, when the experiment was discontinued.

Experiments on the Codling Moth and Curculios.

(*Carpocapsa pomonella*, Linn.; *Anthonomus quadrigibbus*, Say.; *Conotrachelus nenuphar*, Herbst.)

By S. A. Forbes.

No insect has been longer or more unfavorably known to the apple grower than the codling moth. It is a denizen of the whole earth, wherever the apple has found a home, and has probably infested that fruit in the old world at least, from immemorial time. It was first described as a species by the great Linnæus a hundred and thirty years ago, at which time its injuries to the apple seemed well known; and there has doubtless been no year since when it has not deserved and received the heart-felt anathemas of the fruit grower over a large part of the civilized world. It would seem, at the first blush, remarkable that there should be anything further to say concerning an insect that has centered upon itself for so long a time an extraordinary share of the deeply interested attention of the horticultural world; but in this case, as in very many others, our knowledge, gathered by chance, by a great many observers, and systematically and perseveringly studied by none, is fragmentary and indefinite,—our acquaintance with remedial measures especially falling far short of the completeness and accuracy necessary to guide us to a correct practice.

Dismissing for the present all other parts of the subject, it is my purpose here to confine myself wholly to a report of some systematic experiments with remedial measures made by me and my assistants during the summer of 1885,—only incidentally mentioning the life history and habits of the insect, as related to the character and value of the remedies used.

While the investigation to be here reported was originally planned for the codling moth alone, we found ourselves engaged almost as deeply with the plum and apple curculios as with this former insect; and for this reason enlarged the field of our experiment so as to cover all three of these species together.

Until quite recently the standard measures of defense against the codling moth have been but two,—the destruction of the fallen fruit with the larvæ or "worms" within it and the application of bands of rags, or similar material, to the trunks of the trees as a temptation to the larvæ seeking a suitable place for pupation,—the pupæ found under the shelter of these bands being removed and destroyed at short intervals. Both of these remedies have the very

decided disadvantage that they apply only after the insect has done all the damage that it individually can, and that they can consequently only tend to diminish the mischief done by the following generation; hence if these remedies are not generally applied throughout a considerable district, there is always a probability that the best efforts of the most faithful fruit grower will be largely disappointed through the indifference of his neighbors.

Among the older European authors some other remedial measures are frequently mentioned, but they serve us only to illustrate a condition of horticultural enterprise amusingly different from that of Illinois. Thus Köllar speaks of a remedy as chiefly applicable to apples grown in pots; and Boisduval describes a French practice of killing the larvæ inside the apple with an iron needle, afterwards stopping the holes with wax. Of late years, since the advance of the Colorado potato beetle has familiarized fruit growers with the arsenical poisons as insecticides, these have been quite frequently and positively recommended for the codling moth, by high authority, both scientific and practical.

For example: the Hon. J. N. Dixon, of Iowa, in a prize essay submitted to the State Horticultural Society at its meeting in 1882, says that he considers the arsenic solution as complete a remedy for the codling moth as for the canker worm, continuing,—"When the apples are from the size of a bird-shot to the size of a pea, if the orchard is carefully sprinkled with arsenic water, at the rate of one pound of white arsenic to 200 gallons of water, it will not leave a canker worm, codling worm, tent caterpillar, or Bucculatrix in the orchard."

Prof. A. J. Cook, of the State Agricultural College of Michigan, says: "It is now settled beyond question that the arsenites are the cheapest and most efficient specific against the codling moth."*

Mr. H. Shepley, a fruit grower, of Nevada, Missouri, reported in 1884 to the Horticultural Society of that State an account of his experiments in spraying orchards with London purple, and a synopsis of this article as published in the Country Gentleman for June 12, 1884, is cited. He says: "We have never known an instance out of many trials where this treatment [spraying with Paris green] was not entirely successful with the canker worm, or where it did not destroy most of the codling worms, and give much fair fruit which before was nearly ruined with this insect. In rainy weather it should be repeated two or three times, the first applications being washed off."

Attention has also been especially called, from time to time, to the use of lime as an insecticide for the codling moth, these recommendations being apparently based upon statements of the late Dr. E. S. Hull, of Alton, formerly State Horticulturist of Illinois. I do not find any experiments recorded by Dr. Hull himself, but in the "Prairie Farmer" for November 20, 1880, we read:—"But a safer insecticide, and we think equally sure to kill all soft-bodied insects, is air-slaked lime,—lime slaked into fine powder by exposure to the air and freely dusted over the leaves. The late Dr. Hull, of this

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* "Experiments with Insecticides," published in the Proceedings of the First, Second and Third Meetings of the Society for the Promotion of Agricultural Science, p. 112.

State, considered this *the* remedy for the codling moth. To destroy this noxious insect, the lime powder should be plentifully thrown on the apple-tree in the spring, immediately after the petals fall from the blossoms. At this time the eye of the apple in which the moth deposits its egg opens upward, the lime falls in the opening, and a small particle of it is either distasteful to the moth or destroys the egg before it hatches, and it is questionable if the poisons would do this."*

It was my first intention to experiment with all the known methods of attack upon the codling moth not manifestly absurd on their face, for the purpose of making a comparative test of their value and cost, but the general failure of the apple crop in our region made it impossible to find trees enough well loaded with fruit within any practicable distance from the office. The experimental orchards on the University farm were not available, both for the above reason and because they are pastured by stock; but I finally secured from G. F. Beardsley, Esq., of Champaign, the privilege of experimenting in an orchard situated about a mile from the office, in which were found ten bearing trees suitable for my purpose. Under these circumstances I decided to use the opportunities for experiment available, in a way to test as thoroughly as practicable the most popular arsenical poisons and lime. So I appropriated these ten trees to three experiments,—one with Paris green, one with London purple, and one with lime. The Paris green experiment was made on two trees, two others of the same variety, as nearly like them as possible, being selected at the same time as checks on the experimental trees. The London purple experiment was tried on a single tree, and the lime application on two, these also being guarded by check trees not treated at all.

The spraying began on the 9th June, at which time the apples on the trees selected averaged about a quarter of an inch in diameter,—that is, they were about as large as small peas. An earlier beginning would perhaps have been desirable on theoretic grounds, but we shall find evidence that the date was early enough to preclude possible injury to the apples by the codling moth. At any rate, as it happened, I could not complete all the necessary arrangements before this date.

We used at first the Cyclone Nozzle made by the United States Entomological Bureau, our example being furnished me by Dr. Riley; but the assistant in charge of the spraying experiments objected to this as liable to clog with the Paris green, and after much experimenting with a variety of nozzles, I finally selected the Deflector Spray and Solid-Jet-Hose-Nozzle, manufactured by the Lowell Faucet Company, Lowell, Massachusetts. This has the especial advantage of complete and ready adjustment to any requirement, being easily changed while in action by turning a ring, thus throwing, at the will of the operator, anything from a solid stream to the finest spray or an almost imperceptible mist. This nozzle was attached to the end of a strong rubber tube long enough to reach from the ground to the

* Prof. Beale, of Michigan, is reported by the "Prairie Farmer" for May 26, 1883, to have experimented with slaked lime thrown upon the trees at different times when they were in fruit, but without any effect upon the number of moths or wormy apples.

top of the highest tree in the orchard, into which it was lifted on the end of a long light pole. The fluid was carried in a can and applied by means of a hand force pump. More convenient arrangements for work on a large scale might easily be devised, but the foregoing answered our experimental purpose well.

The spray was applied so thoroughly that we had no doubt, in any case, that every apple was reached and bedewed by it. The finer particles of water were so minute that they floated on the air and were carried by the gentlest breeze, a rainbow forming readily in the mist when thrown towards the sun. In fact, the spray thrown by the adjustable nozzle was so delicate that at the height of the tree-top it was sometimes scarcely visible, except when brought between us and the sun. Notwithstanding this minute subdivision of the fluid, it evidently conveyed the Paris green, as the nozzle very rarely clogged either with that or the London purple. The poisons were kept suspended in the water by frequent stirring, and the spray was thrown until the leaves began to drip. Applied in this way we found about two gallons of fluid sufficient for a large apple-tree. The time occupied averaged about four minutes to a tree.

For the purpose of testing the results of the various applications used, the fallen apples were picked up at short intervals and carefully examined one by one, the number affected by the codling moth and by curculios being separately noted, and also those injured in miscellaneous and undetermined ways. The number which showed no traces of injury, belonging to each tree, was recorded with the others, and these records were kept until the end of the season. The ripened apples were then picked, and these also were handled in the same manner, every apple from all the trees treated, as well as from all the checks, having thus been individually examined, and in most cases cut in two. Something of the amount of work done in this study may be inferred from the fact that the number of apples thus separately scrutinized was 16,529.

From the data thus obtained, calculations have been made, for each collection and each experiment, of the number of apples affected by the codling moth, by the curculios, and by all other causes taken together, and of the ratio of these to the whole number of apples from each tree. The data thus obtained have been carefully worked out, by comparison and cross-comparison, in a manner the details of which I need not give you here, as they will all be exhibited in the tables accompanying this paper.

Before I begin any detailed account of the experiments, or statement of the results, I wish to call especial attention to the exceptional circumstances of the year, and to the consequent peculiar and provisional value of the conclusions based upon the season's work. The crop of the year preceding had been very abundant throughout the entire region around Champaign; and, in fact, the apple orchards had averaged a fair yield at least, for some years in succession, so that apple-feeding insects had had more than a medium opportunity for multiplication. When the spring opened this season, they must, consequently, have been present in more than average numbers. But the extremely short crop of this year necessarily afforded them relatively little food, and hence what apples

there were must have received the concentrated and inordinate attack of a relatively excessive number of codling moths and curculios. The conditions, therefore, were as unfavorable as possible to the success of our experiments,—or, rather, to the effectiveness of the remedies. While this fact renders the results of our work insufficient as a guide to the remedial measures in ordinary years and under ordinary circumstances, it nevertheless gives them a peculiar value as showing what could not have been shown under other circumstances, viz.: the best these remedies can do under the most *unfavorable conditions*.

All the applications made were repeated much more frequently than would be either advisable or economical in practice, and carried later into the season than would be either reasonable or safe, the object being, as already intimated, to determine the greatest possible effect under the circumstances existing. I wish, therefore, especially to emphasize the fact that this paper is not to be taken as conclusive upon the questions raised, but as a contribution to progress on the subject, our experiments requiring to be repeated at least one other year. Indeed, as a basis of a complete estimate of the value of any remedial measure against the codling moth, we should have an account of its effect during one year of excessive relative abundance of the insects, another of average abundance, and still another of unusual scarcity. This paper is a contribution to a knowledge of the value of these remedies under the first circumstances mentioned.

The detailed results of all our experiments and observations I have arranged in the form of tables exhibiting the date of each experiment; the dates when the successive lots of apples were examined, whether fallen fruit or that picked at the end of the season; the total number of apples examined in each lot and its check; the number of apples uninjured in each; and the number of those injured by the codling moth, by the curculio, and by causes indeterminable. Summaries have been added showing the total number, in each case, injured by insects of all sorts, and the total number injured in any way. Under each of these various heads I have also calculated the *ratios* of each injury to the entire number of apples examined.

The remainder of this paper will be devoted to a detailed discussion of the principal facts presented in these tables, followed by a concise summary of the main results.

PARIS GREEN.

The Paris green with which I experimented was bought of E. H. Sargent & Co., of Chicago, having been obtained by them, as I afterwards learned, from some wholesale grocer in the city, whose name they could not give me. As analyzed by my colleague, Prof. McMurtrie, it proved to be considerably adulterated,—or, at any rate, contained a much smaller proportion of arsenic than the current statements concerning the composition of Paris green would lead us to expect. The ratio of arsenic in the specimens submitted for analysis was 15.4 per cent. In our practice three fourths of an

ounce, by weight, of Paris green was stirred up in two and one half gallons of water,—this quantity being sufficient to give the fluid a distinct green tint.

The percentage of Paris green in the fluid was about twice the strength ordinarily recommended for use in orchards by those who claim to have tested the arsenical poisons for the codling moth.

Two trees were treated, both of the same variety, and both having checks likewise of that variety. The first of these trees was first sprayed June 9, and the second June 13, no other difference than this initial one of dates being made throughout the season. Each was sprayed eight times, at intervals ranging from the 9th June to the 3d September. The comparative results as shown by my tables differ so little for these two trees, and for their checks, that both couples may be considered as one.

THE CODLING MOTH.

A careful examination of a large number of apples on the treated trees was made upon the 7th July, one month after the first poisoning. At this time we failed to find an apple on either of these trees giving any evidence of injury by the codling moth, while the check trees adjoining, so close that their branches touched, bore a large number of infested apples.

The first examination of fallen fruit was made July 16, five weeks after the treatment of the first tree, and four and a half weeks after that of the second. Both these trees had now been treated four times in succession; the first on the 9th and the second on the 13th June, and both trees on the 20th and 30th June and on the 15th July. Of the 214 fallen apples from the poisoned trees, examined July 16, only 16, or 7.9 per cent. were affected by the codling moth; while of the 570 apples examined from the check trees, which had not been treated with Paris green, 58 per cent. had been so injured, —more than seven times as large a ratio of these fallen apples having been attacked by the codling moth on the check trees as on the trees sprayed with Paris green.

The fact that in both cases the percentage of injury by the codling moth to the fallen apples was smaller at this time than at any subsequent examination is sufficient evidence that the experiment was begun early enough to meet the insect in the beginning of its career.

To exhibit more exactly the method of our work and the basis of my conclusions, it may be worth while to follow through the history of one of these trees to the end of the season, so far as injuries by the codling moth and curculios are concerned.

To get some idea of the condition of the fruit *upon the tree*, we critically examined, July 21, 100 apples selected at random upon each of the two contrasted trees,—the one poisoned with Paris green and its check. Of the 100 apples upon the poisoned tree, only two were infested by the codling moth, while of those upon the check 33 had already been attacked.

The second examination of *fallen* apples was made July 24, at which time 177 were picked up from under the poisoned tree and

370 from under its check. 23 per cent. of the former now showed injury by the codling moth and 63 per cent. of the latter. Next, July 31, the trees having been sprayed the previous day, 53 apples were collected under the poisoned tree and 120 under its mate, 14 per cent. of the former being wormy and 70 per cent. of the latter. Again, August 7, lots of 93 and 61 apples, respectively, were collected from beneath these two trees. 21 per cent. of those from the tree sprayed with Paris green were found invaded by the pest—as against 56 per cent. of those from the tree not treated. August 27, 84 per cent. of the poisoned apples fallen were infested and 70 per cent. of those not poisoned. September 3, the ratios were respectively 47 and 79 per cent.

The number of fallen apples examined *during the season* amounted to 665 from the poisoned tree and 1,037 from the other. Of the former 22.7 per cent. were injured by the codling moth; of the latter 65 per cent., the injuries to the fallen apples from the experimental tree being thus a trifle over one third of those from the check. On the 10th September the apples were finally picked from both these trees,—846 from the first and 783 from the last.

It will be noted, in passing, that a much greater percentage of apples had fallen from the tree not treated than from its mate, the ratios of fallen apples to the entire number upon the trees in the beginning being 44 per cent. in the first case and 57 per cent. in the second.

Of these ripened apples 178 were damaged by the codling moth on the experimental tree and 591 on its companion, the ratio for the poisoned tree being 21 per cent. and for the other 75 per cent.; or, roughly, one fifth of the ripened apples on the tree sprayed with Paris green had been damaged by the codling moth and three fourths of those on the other. Finally, if we take fallen and ripened apples together, 1,511 from the poisoned tree and 1,820 from its check, we find that the codling moth had damaged 22 per cent. of the former and 70 per cent. of the latter,—something over three times as great a ratio for the tree not treated as for that which had been sprayed. Or, more briefly, two thirds of the apples which would otherwise have been damaged by the codling moth, were saved by the Paris green.

Turning now for a moment to the second tree, similarly treated, I notice that the ratios for the total product of this tree differ so little from those just given, that it is not worth while to detail them here; the ratios, for example, of both picked and fallen apples from the two treated trees being respectively 22 and 20, and for the two checks, 69 and 65. Finally, lumping the results from these four trees, the two poisoned with Paris green and their two checks, the first represented by 2,418 apples and the second by 2,264, we find that the codling moth had left its mark upon 21 per cent. of the former and upon 68 per cent. of the latter; that is, more than three times as many apples were damaged on the trees not treated as upon those which had been sprayed. In a word, crowding the remedy to the utmost, we saved under exceptionally unfavorable circumstances, two thirds of the predestined victims of the apple worm.

THE CURCULIOS.

Since Paris green has been very generally recommended as a protection against the ravages of the curculios, both for plums and apples, we kept as careful a record of curculio injuries as of those by the codling moth. The results will be disappointing to those who have formed their opinions of the efficacy of Paris green as a curculio poison from some of the reports made by fruit growers. Although a single spraying with Paris green has been reported to completely defend the crop against the curculios for an entire season, we found this agent decidedly less effective against these insects than against the codling moth.

Of the 1,975 apples from these two poisoned trees which were examined for the curculio injury, 542, or 27.3 per cent., bore the brand of these insect beaks; while of the 1,172 obtained from the check trees, 602, or 57.3 per cent., had been so injured, the ratio of apples punctured by the curculios on the poisoned trees being nearly half as many as on those trees which had not been sprayed. An inspection of our tables shows that this was a fact apparent throughout the season.

Considering the picked apples only, the result is somewhat more favorable than if the fallen apples also are taken into account; the percentage of those damaged by the curculios on the check tree being 76.5, and upon that sprayed with the Paris green, 34.4 per cent.

The work of both the apple and the plum curculio was abundant upon these trees, the latter being, however, greatly in excess; and these statements apply to both these species. In fact, I may say here, that wherever we kept a complete record of all curculio injuries, we found these to average almost exactly half the number of those by the apple worms,—evidence that the "Little Turk," rarely noticed by the apple grower, is really among his very worst and most dangerous enemies, destined, unless I am much mistaken, greatly to increase in numbers and destructiveness.

If we take the codling moth and curculios together, adding, that is, all recognizable insect injuries to those apples, we shall find that the Paris green diminished the total almost exactly one half, 44 per cent. of the apples on the poisoned trees being damaged, and 86 per cent. of the others.

Occasionally apples were found apparently injured by insects, but not in a way to make it possible to determine to what species the injury was due. These cases I have tabulated as undetermined injuries. They amounted to about 18 per cent. of all the apples examined which were not clearly injured by codling moth or curculio.

It will be a matter of interest to report, while I have the data in hand, the percentage of the fruit whose *falling* was due to injury by the codling moth and curculios. Taking only the two check trees into account, we find that of the 1,859 apples which fell during the season, 1,539, or 82 per cent., had been injured by one or both of these insects, the remaining 18 per cent. having fallen from causes not perceptible.

COST OF THE EXPERIMENT.

So much for the dance; now what must we pay the fiddler? Do apples raised with a force pump and fed on poison, possibly cost more than their market price? Excluding interest on the cost of the apparatus, which is too slight to be taken into account, the expenses of application are covered by the cost of labor and material. The former, in our case, amounted, for the season, to the hire of two men for thirty-two minutes per tree, and the latter reached a sum of 22½ cents per tree, the total amount of Paris green for each tree being six ounces for the season—here reckoned at 50 cents per pound. It is evident that the Paris green was used by us in excessive quantity, and we shall soon find that the trees were sprayed more frequently than was necessary or expedient. Further, if special contrivances were used for the distribution of the fluid in an orchard, the time per tree for a single spraying would doubtless be considerably lessened as the laborers became expert at the work, so that I do not doubt, upon the whole, that 10 cents per tree, for the season, is a fair estimate of the necessary cost of a sufficient use of Paris green to give the full effect of the remedy.

DAMAGE TO THE TREES.

Used with the strength and frequency of our experiments, the Paris green conspicuously burned the leaves. Probably from one third to one half of those upon the experimental trees were more or less scorched and withered at the edges, and a greater part of the leafage fell in autumn somewhat prematurely. In fact, our notes show that the leaves from one of these trees were falling rapidly July 31, the tree treated with London purple being similarly affected. We had some evidence that the fruit itself was injured in our case, a surface discoloration and subsequent local rotting of the apples being most evident on that side of the tree towards the prevailing winds with which the greater part of the spraying was done. Thus the rather nice question is raised, in our experiments, whether our gain in apples was not lost in damage to the tree. We had saved some fragments of the golden egg, but had we not possibly crippled the goose by our heroic surgery? It is not to be presumed, however, from the above, that this damage to fruit and foliage is a necessary consequence of the use of Paris green. It is doubtless to be attributed partly to the purposed excess with which we applied the poison, and partly to our lack of experience in spraying in the beginning of the season.

DANGERS TO STOCK.

It of course goes without saying that no poisonous substance should be applied in an orchard to which stock is admitted.

DANGERS TO HEALTH.

Keeping in mind the fact already repeatedly alluded to, that our use of Paris green in these experiments was excessive, it will be worth while to report the result of a chemical analysis. From one

of the trees last sprayed September 3, apples were picked on the 10th of that month and brought to the office in a sack. From these, sound examples were taken at random and submitted to Prof. William McMurtrie, of the chemical laboratory of the University, for analysis. According to his report* these apples averaged .9 milligram of arsenic each,—an amount such that seventy-four apples would convey a poisonous dose.

During the interval between the last spraying and the harvesting of these apples, a violent storm had occurred, an inch or more of rain falling, and the wind blowing a gale for two days.

These facts clearly indicate that exposure to a week's ordinary weather, with heavy rain and wind, is not sufficient to free the apple from a dangerous amount of Paris green.

Remembering that arsenic is one of those substances likely to have a cumulative effect if taken long in small quantities, remaining in the system and finally producing powerful results from very small doses, it will be seen that it would not do to have the family apple supply dusted, even very lightly, with any arsenical substance. I only mention these matters to indicate the great importance of a careful investigation as to the length of time and the circumstances within which Paris green may be safely used in the orchard. Certainly we may say that it would be quite inexcusable to apply it during the latter part of the season, or, indeed, for some time previous to the ripening of the apples, whether they are early or late.

As the codling moth continues its attack throughout the entire summer, small larvæ appearing in our collections as late as September, it is clear that Paris green, even if completely effective when thoroughly applied, cannot be relied upon wholly to prevent injury by this insect. During the latter part of the season, when its use is inadmissible, the apples will be subject to damage by the later codling moths.

LONDON PURPLE.

The London purple experiment was in all respects similar to that with Paris green, except that a somewhat smaller ratio of the poison was used and that only one tree was carried through the

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*UNIVERSITY OF ILLINOIS, DEPARTMENT OF CHEMISTRY,
CHAMPAIGN, Ill., October 20, 1885.

Prof. S. A. Forbes, State Entomologist:

DEAR SIR: I have the honor to submit the following report upon examination for arsenic upon apples from trees which had received arsenical spray for destruction of insects.

The apples were preserved, as received, in a closed box until needed for examination. First one was taken and submitted to qualitive test for arsenic by the application of the Marsh test. The presence of the poison was detected. To determine the quantity of arsenic present another and large apple was selected, treated to destroy its organic constituents, and the arsenic separated in the metallic state by means of the Marsh apparatus as before. The results are as follows:

Weight of apple taken, 76.025 grammes; weight of arsenic secured, 0.0009 grammes; percentage of arsenic, 0.0013.

Respectfully submitted.

WM. McMURTRIE, E. M. Ph. D.,
Prof. of Chemistry, University of Illinois.

season. A second tree, sprayed in the beginning, was abandoned because the orchard in which it was situated was pastured with cattle.

The London purple used was obtained from the Hemmingway London Purple Company, New York, with the understanding that it was intended for experiment and under a promise to report the results to them. There is consequently every reason to suppose that it was a good sample of the article. By Prof. McMurtrie it was found to contain 22.25 per cent. of metallic arsenic. Comparing this ratio with that given for the Paris green we find that in applications of the latter substance we used the equivalent of 50.5 grains of metallic arsenic to the bucket of water (20 grains to the gallon) and in the London purple applications 37.2 grains of arsenic to the same (nearly 15 grains to the gallon),—the Paris green fluids being thus about one third stronger in arsenic than the London purple. In Paris green the arsenic is combined with copper to form an arseniate of copper, while in London purple it is combined with lime to form the arseniate of lime. Whether this difference in composition is likely to make any perceptible difference in the insecticide activity of the two substances, I am unable to say.

The tree was treated eight times, as in the Paris green experiment, commencing June 13 and ending September 3, and, as usual, a check was selected in its immediate vicinity, not treated at all. The course of events was in all respects similar to that detailed under "Paris Green," except that the differences between the poisoned tree and its check were, all along, less than in the other experiment. For example, 34 per cent. of the fallen apples obtained July 16 from the poisoned tree had been injured by the codling moth as against 52 per cent. from the check, while the corresponding Paris green trees gave us at this date, it will be remembered, 7 per cent. and 53 per cent.

Examining the whole number of fallen apples collected during the season, we found that of 1,048 from the experimental tree, 495, or 47 per cent., had been penetrated by the larva of the codling moth, while of the 1,828 apples gathered under the companion check, 1,040, or 57 per cent., were so injured. Of these fallen apples, consequently, the number injured in the check lot was only about 10 per cent. greater than those injured in the experimental collection. The picked apples at the end of the season gave a similar result, 61 per cent. of those on the experimental tree having been injured by the codling moth and 76 per cent. of those on the check,—a difference, in this case, of only 15 per cent. in favor of the poisoned tree.

Taking all the apples, both fallen and ripened, we find that 49 per cent of those treated with London purple were injured and 59 per cent. of those not so treated; again a difference of only 10 per cent. in favor of the experimental lot. Comparing the general averages of these London purple trees with those of the trees sprayed with Paris green, we see that the latter application was from two to three times as effective as the former—both being used in quantity to burn the foliage.

The showing was very nearly the same for the curculios as for the codling moth,—39 per cent. of the apples injured where the tree had been sprayed with London purple, and 48 per cent. where it had not been so treated.

For the remaining particulars of this experiment, I refer the reader to the tables appended to this paper, adding only the fact that the entire number of apples handled from these two London purple trees was 3,241. Late in the season some scorching of the leaves similar to that attributed to the Paris green was noticed on this London purple tree; less serious, however, than in the other case.

LIME.

Lime has been commonly used as an insecticide, in the form of a powder to be dusted on the plant, but as this mode of distribution is very inconvenient in the orchard, we applied it in the same way as the arsenical poisons, stirring it up in water and throwing it upon the tree with a pump.

No exact measurement was made of the ratio of lime to water, but as large a quantity was used as could be conveniently managed, no degree of injury to the foliage being anticipated.

Fresh air-slaked lime was mixed with water and thrown immediately upon the tree. A quantity was used sufficient to whiten the leaves slightly as the water dried away. The same number of applications was made as in the other experiments, commencing June 13, except that the apples on one of the trees ripened before the date of the last spraying, and consequently this tree received but seven applications. The first two trees selected, the experimental tree and its check, were of the same variety and in all respects similar. The first spraying was extraordinarily profuse on account of the frequent stoppage of the cyclone nozzle with the particles of lime, several buckets of lime water being used to each tree.

On the 7th July a cursory search was made for the codling moth, and one example was found upon each of the two trees sprayed. The lime of the last spraying, done a week before, was still visible on the leaves, notwithstanding several intervening showers. From the examination of the fallen apples collected under this tree and its check, there was no evidence of any effect upon the codling moth, 53 per cent. of the 1,615 apples from the experimental tree having been burrowed by the worms, as compared with 46 per cent. of the 1,609 apples from the check. The same inefficiency of the lime was indicated by an examination of the apples upon the trees, 200 apples upon the treated tree containing, July 21, 18 larvæ of the codling moth, and 200 from the check containing 16 such larvæ. The picked apples gave only a slightly different result; 70 per cent. of those treated with lime contained the codling moth and 78 per cent. of those not so treated. The final ratios for the year, including both fallen and ripened apples, were 54 per cent. of wormy apples for the tree sprayed with lime water and 50 per cent. for

its companion, the first tree bearing, all told, 1,706 apples and the second 1,825. The effect upon the codling moth of treatment with lime was, consequently, absolutely nothing.

With respect to the curculios, however, the case was slightly different, the lime having apparently some perceptible effect on the numbers of these insects. Almost exactly one third more apples had been damaged by the curculios on the trees not treated than on those sprayed with lime water,—the ratios being respectively 29.6 and 38.8 per cent. for the picked apples, and 31 and 40.6 per cent. for all the apples of the season taken together. By a very remarkable coincidence, the two ratios representing all descriptions of injury to the fruit of these two trees were precisely alike,—72.6 per cent. for each. As the final result of this experiment, we must conclude that time spent in treating the apple orchard with lime for the codling moth would be wholly thrown away. So much for the first tree.

When I came, however, to tabulate and inspect the record of the second, I was astonished and puzzled by a totally different exhibit of results. Of the ripened fruit of this second tree sprayed with lime water, only 4.5 per cent. was wormy, while of the check selected for comparison, 71 per cent. had been affected by the codling moth,—an enormous and surprising difference. Taking together the fallen fruit and that harvested at the end of the season, the ratios for the lime-water tree and its mate were, respectively, 25.5 and 67.5 per cent.,—facts which seemed altogether irreconcilable with the conclusions drawn from the preceding table. A closer inspection of the history of this experiment brought out, however, some interesting points, which not only serve to explain this discrepancy, but also give us some unexpected information upon a subject not taken into account in planning these experiments. Owing to the limited number of trees from which the selection was made, it was impossible to find a proper mate for the tree last treated with lime, the check used being of a different variety and containing only a small number of apples, while the tree treated was much the most heavily loaded of any covered by these experiments. From the latter 3,555 apples were taken; from the former only 820, the lime-water tree thus bearing more than four times as many as its fellow. A great quantity of these limed apples, 2,869 in number, fell during the summer, leaving only 686 apples (about two bushels) upon the tree at the end of August, and nearly half of these fallen apples were dropped without apparent injury. Clearly, the other tree, starting with so small a number of apples and dropping only a little more than half of them, was totally unfit for a check upon this. Now, besides the differences between these two trees with respect to the lime-water treatment and the number of apples borne by each, the only other perceptible difference was in the variety of apple. Both were early apples and of similar texture, but evidently not of the same kind. It is not supposable that a mere difference in variety, not involving a difference in season or important difference in quality of fruit, could have any influence on injuries by the codling moth; neither have any observations to this effect been made by either entomologists or fruit growers, so far as I am aware, all varieties of similar quality being equally subject to injury by this insect. (Taschenberg reports, how-

ever, that the finer apples are more liable to attack than the coarser kinds.) We have left, then, only the difference in abundance of apples upon these two trees to account for the extremely different ratios of insect injury. It would seem that each tree in the orchard attracts an approximately equal share of codling moths, and that when a tree bears but few apples, a large percentage of these will be attacked; while if the apples are numerous, the attack will be less concentrated, and the ratio of injury proportionally diminished. These circumstances will perhaps explain some of the extravagant claims set up for the efficiency of arsenical poisons and other remedies as applied to the codling moth and the curculios. If I had ventured to report to you upon the strength of a single instance, and if that instance had happened to be the present, I should have asserted no less positively than others the remarkable value of lime as a remedy against the codling moth or apple worm.

NATURAL HISTORY OF THE CODLING MOTH.

This insect is currently reported to breed twice during the year, one brood of the moths appearing in early spring, and the second in midsummer. The most elaborate observations made upon its life history with which I am acquainted, are those reported by Mr. Charles G. Atkins in the "Agriculture of Maine" for 1883, and as a result of his observations, he concludes that, in the latitude of Maine, at least, only a single brood occurs, distributed in its development over a considerable part of the season. Our collections and observations made this year show, however, that in central Illinois the insect is unquestionably two-brooded, the moths of the second brood occurring in July. On the 24th July, at which date nearly 1,100 apples injured by the codling moth larvæ were examined, not over a dozen of these larvæ were found in the fruit. A single pupa also occurred in an apple. Curculio larvæ, it may be worth while to note, were at this time decidedly abundant. On the 31st July, again, no mature larvæ whatever were found, but a few very small ones were detected at the blossom end of the apple,—evidently young of the second brood. By August 7 the average length of forty examples removed from the apples, was 7.6 mm.—a little more than one fourth of an inch—while, by the 27th August, the average of twenty examples was 10.1 mm., or about two fifths of an inch. On the 31st of this month, three fourths of the apples injured by the apple worm still contained the larvæ, many of them in the blossom end of the apple, and so small as to be difficult of detection. This circumstance is of interest as showing that the second brood is more numerous than the first,—a reason additional to those already mentioned why no complete protection to the fruit can be afforded by spraying only early in the season.

CONCLUSION.

And now, in conclusion, I will give you a summary and brief recapitulation of the whole matter:

(1). The investigation was undertaken to test the efficiency of lime and arsenical poisons as insecticides for the codling moth and apple and plum curculios in the apple orchard.

(2.) Owing to the scarcity of apples and the abundance of apple insects, the season was the most unfavorable possible for the success of these remedies.

(3.) The insecticides were applied suspended in water, the Paris green in the ratio of one and a half ounces to five gallons, the London purple in half that weight, and the lime in indefinite amount.

(4.) The spraying with Paris green began when the apples were about as large as currants; and four days later, with the London purple and lime.

(5.) All the trees were thoroughly sprayed seven and eight times between June 9 and September 3.

(6.) The fallen apples were gathered six times from July 16 onward, and those remainining were picked as they ripened.

(7.) All the apples, both fallen and ripened, 16,529 in number, were examined individually for insect injuries, and those due to the codling moth and curculios were separately noted.

(8.) As a result of the examination of 2,418 apples from trees which had been sprayed with Paris green, and of 2,964 others from check trees which had not been so treated, it appeared at the end of the season that 21 per cent. of the poisoned apples had been infested by the codling moth and 67.8 of those not so treated; while 27.3 per cent. of the poisoned lot had been infested by the curculios and 51.3 per cent of those not sprayed. That is to say, treatment with Paris green had saved something more than two thirds of the apples which would otherwise have been damaged by the codling moth, and something more than half of those which would have been sacrificed to the curculio. It should be remembered in this connection that the Paris green not only serves to protect the apples from attack, but by actually destroying the insects must assist to lessen the amount of insect injury in succeeding years. Analysis of apples one week after treatment with Paris green, a heavy storm intervening, gave abundant evidence that this insecticide could not be safely applied for some weeks preceding the harvesting of the fruit.

(9.) As a result of the comparison of 1,205 apples from a single tree sprayed with London purple, and 2,036 apples from a check tree not so treated, it appeared that 49 per cent. of the former were affected by the codling moth and 58.8 of the latter, and also that 39 per cent. of the first lot of apples had been invaded by curculios and 48 per cent. of the second lot. The London purple thus saved about one sixth of the apples which would otherwise have been sacrificed to the codling moth and about one fifth of those otherwise to be spoiled by the curculios.

In comparing these results with those derived from the Paris green experiment it must be remembered, however, that the spraying with London purple began four days later than that with Paris green, and that the latter, as used, contained about one third more arsenic than the former. It should be further noted that both were applied to the limit of considerable damage to the foliage, conspicuous as early as the last of July.

(10.) 1,706 apples obtained from a tree treated with lime, as compared with 1,825 apples collected from a tree of the same variety used as a check, show that 53.9 per cent. of the former contained the apple worm, and 49.8 per cent. of the latter, thus indicating the uselessness of this substance as against the codling moth. A similar application made to a tree heavily loaded with fruit, bearing in all 3,555 apples, and placed in comparison with a tree of another variety bearing only 820 apples, serves merely to show that the ratio of codling moth injury to the fruit of a single tree depends largely upon the number of apples borne. The lime had no injurious effect whatever upon the foliage. While producing some effect on the curculios, seemingly lessening the damage about one fourth, lime is less efficient in this respect than Paris green.

(11.) As bands for traps serve only to capture the apple worm after it has done its mischief, and hence only interpose a general protection against future attack, and are moreover liable to be rendered ineffectual by the neglect of one's neighbors, the use of Paris green will serve at least as a valuable addition to remedial measures against the codling moth. Since it may be safely applied, however, only for the spring brood, it is best to use both bands and insecticides, each measure supplying the deficiencies of the other.

(12.) Attending only to the picked apples, and condensing our statement of results to the last extreme, we may say that, under the most unfavorable circumstances, Paris green will save, *to ripening*, at a probable expense of ten cents per tree, seven tenths of the apples which must otherwise be conceded to the codling moth; that London purple will apparently save about one-fifth of them; and that lime will save none.

Furthermore, if we must judge from results thus far reached, these various applications are of too slight effect upon the apple and plum curculios to make them worthy of use against these insects, Paris green diminishing curculio blemishes less than one half, London purple about one fifth, and lime not far from one fourth.

(13.) Our observations upon the life history of the codling moth merely confirm the statement of previous observers in this latitude to the effect that the insect is double-brooded. It is apparent, however, that the first attack is not made upon the apple until this has reached the size of a small pea.

For next year I propose, if the conditions are at all favorable, to carry on these experiments on a larger scale, to vary them in such a way as to show the smallest quantity of the poison and the fewest applications that will effect the purpose of protection, and to thoroughly test other remedial measures than those we have studied this year.

Paris Green Experiment 1. Trees 1 (poisoned) and 2 (check).

Trees.	Fruit.	Sprayed.	Examined.	Total No. of apples	Codling moth.		Curculios.		Both	Total Insects.		Undetermined Injuries.		Total Injuries.		Uninjured.	
					No.	Pr. ct	No.	Pr. ct		No.	Pr. ct	No.	Pr. ct	No.	Pr. ct	No.	Pr. ct
1	Fallen	June 9, 20, 30	July 16	141	10	7.1	28	21.3	Not separately reported.	38	27.0	10	9.7	48	34.0	93	66.0
2	"		"	244	130	53 2	12	10.5		142	58.2	35	34.3	177	72.5	67	27.5
1	"	July 15	July 24	177	42	23.1	12	9.5		54	30.4	1	.8	55	30.5	122	68.9
2	"		"	370	253	68.4	66	56.4		319	85.4	4	7.8	323	85.5	47	13.0
1	"	July 30	July 31	56	8	14 3	12	25.0		20	36.3	1	2.7	21	38.1	35	63.6
2	"		"	120	84	70.0	23	63.8		107	89.0	0	0.0	107	89.0	13	10.8
1	"	Aug. 5	August 7	93	20	21 5	27	36 9		47	50.5	4	8.7	51	54.8	42	45 1
2	"		"	61	34	55.7	19	70.3		53	86.8	2	25.0	55	90.1	6	9.8
1	"	Aug. 27	August 27	168	57	33.9	48	43.2		105	62.5	2	3.1	107	63.6	61	36.3
2	"		"	189	133	70.3	42	75.0		175	92.5	4	28.0	179	94.7	10	5.2
1	"	Sept. 3	September 3	30	14	46.6	3	18.9		17	56.6	3	23.0	20	66.6	10	33.3
2	"		"	53	42	79.2	8	72 7		50	94.3	0	0 0	50	94.3	3	5.6
Total 1	"			665	151	22.7	130	25.2		281	42.2	21	5.4	302	45.4	363	54.5
Total 2	"			1,087	676	65 1	170	47.0		846	83.3	45	25.6	891	86.7	146	14.0
1	Picked	Sept. 3	September 10	846	178	21 1	230	34 4		408	49.2	184	42 0	592	69.9	254	30.0
2	"		"	788	591	75.4	147	76.5		738	94.2	19	42.2	757	96 6	26	33.0
Grand total 1				1,511	329	21.7	360	30 4		689	45.6	205	25.2	894	58 0	617	40.8
Grand total 2				1,820	1,267	69.6	317	57.3		1,584	87.0	64	27 1	1,648	90.5	172	9.4

Paris Green Experiment 2. Trees 3 (poisoned) and 4 (check).

3	Fallen	June 13, 20, 30	July 16	73	6	8.2	11	16.4		17	23.2	10	17.8	27	36 9	46	63.0
4	"		"	326	205	62.8	56	46 2		261	80.0	8	12 3	269	82.5	57	17.4
3	"	July 15	July 24	114	31	27.2	15	18.0		46	40.3	0	0.	46	40.3	68	59.6
4	"		"	149	79	53.0	37	52.8		116	77.8	0	0.	116	77.8	33	22.1

3	Fallen	July 30	July 31	74	9	12.1	17	26.1		26	35.1	0	0.0	26	35.1	48	64.8
4	"	"	"	113	51	45.5	41	67.2		92	82.1	0	0.0	92	82.1	20	17.8
3	"	August 5	August 7	48	7	14 5	8	19.5		15	31.2	1	3.0	16	33.3	32	66.6
4	"	"	"	56	30	53.5	19	73.0		49	87.5	0	0.0	49	87.5	7	12.6
3	"	August 27	August 27	267	53	19.4	56	26.0		108	40.4	7	4.4	115	43.0	152	56.9
4	"	"	"	144	129	89.5	13	86 6		142	98.5	0	0.0	142	98.5	2	1.4
3	"	September 3	September 3	81	9	28 9	5	21.7		14	45.1	0	0.0	14	45.1	17	54.8
4	"	"	"	35	31	88.5	2	50.0		33	94.2	0	0.0	33	94.2	2	5.7
Total 3	"			607	114	18.7	112	22.6		226	37.2	18	4.7	244	40 1	363	59.8
Total 4	"			822	525	63.6	165	56.5		693	84.3	8	6.2	701	85.2	121	14.7
3	Picked	September 3	September 10.	301	66	21.9	70	23.2	11	125	41.1	18	10.2	143	47.5	158	52.4
4	"	"	"	322	229	68.3	117	36 3	56	281	87.3	13	31.9	350	93.8	28	8.7
Grand total 3				908	180	19.8	182	22.9	11	351	59.8	36	6.4	387	42.5	521	57.3
Grand total 4				1,144	745	65 1	285	42.8	56	994	85.1	21	14.0	1,051	86.9	149	13.0
Grand total 1 and 3				2,418	509	21.0	542	27.3	11	1,042	43.9	241	17.6	1,280	52.9	1,138	47.0
Grand total 2 and 4				2,964	2,012	67.8	602	51.3	56	2,558	86.2	85	20.9	2,643	89.2	321	10.8

London Purple Experiment. Trees 5 (poisoned) and 6 (check).

5	Fallen	June 13, 20, 30	July 16	444	154	34.6	104	35.8		258	58.1	11	5.9	269	60.6	175	39.1
6	"	"	"	927	486	52.4	197	44 6		683	73.5	2	.8	685	73.7	242	26.1
5	"	July 15	July 24	165	82	49.6	34	40.9		116	70.3	2	4.0	118	71.5	47	28.4
6	"	"	"	366	165	45.0	90	44.7		255	69.6	1	.9	256	69.9	110	30.0
5	"	July 30	July 31	88	35	39.7	36	67.9		71	80.6	0	0.0	71	80.6	17	19.3
6	"	"	"	146	73	50.0	60	82.1		133	92.5	0	0.0	133	92.5	13	9.0
5	"	August 5	August 7	68	27	39.7	33	80.4		60	88.2	0	0.0	60	88.2	8	11.5
6	"	"	"	84	47	55.9	35	94.5		82	97.6	0	0.0	82	97.6	2	2.3
5	"	August 27	August 27	243	171	70 3	20	28.0		191	78.6	0	0.0	191	78.6	52	21.4
6	"	"	"	243	207	85.1	21	58.3		228	93.4	2	13.3	230	94.6	13	5 3
5	"	September 3	September 3	40	26	65 0	3	21.4		29	72.5	1	9.0	30	75.0	10	25 0
6	"	"	"	62	62	100.0	0	0.0		62	100.0	0	0 0	62	10.0	0	0.0
Total 5	"			1,048	495	47.2	230	41.6		725	69.1	14	4.6	739	70.1	309	29.5
Total 6	"			1,828	1,640	56.8	403	51.1		1,443	78.8	5	1.3	1,448	79.0	380	20.8

London Purple Experiment—Continued.

Trees.	Fruit.	Sprayed.	Examined.	Total No. of apples	Codling moth.		Curculios.		Both	Total Insects.		Undetermined Injuries.		Total Injuries.		Uninjured.	
					No.	Pr.ct	No.	Pr.ct		No.	Pr.ct	No.	Pr.ct	No.	Pr.ct	No.	Pr.ct
5	Picked	September 3...	October 9	157	96	61.1	48	30.5	25	119	75.1	2	5.2	121	76.3	36	22.9
6	"	"	"	208	158	75.9	79	37.9	54	183	87.9	6	2.4	189	90.8	19	9.1
Grand total 5				1,205	591	49.0	278	39.1	25	844	70.0	16	4.2	860	71.3	345	28.6
Grand total 6				2,036	1,198	58.8	482	48.3	54	1,626	79.7	11	2.9	1,637	80.4	399	19.6

Lime Experiment 1. Trees 7 (treated) and 8 (check).

7	Fallen	June 18, 20, 30...	July 16	701	210	29.9	78	15 9	.....	288	41.0	64	15.4	352	50.2	349	49.7
8	"	"	"	522	209	40.0	10	3.2	.....	219	41.9	14	14.6	233	44.6	289	55.3
7	"	July 15	July 24	279	161	57.7	51	43.2	.....	212	75.9	0	0.0	212	75.9	67	24.0
8	"	"	"	410	145	35.3	104	59.2	.....	249	60.7	6	3.7	255	62.1	155	37.8
7	"	July 30	July 31	166	100	60.2	47	71.2	.....	147	88.5	0	0.0	147	88.5	19	11.4
8	"	"	"	173	57	32.9	91	78.4	.....	148	85 5	0	0 0	148	85.5	25	14.4
7	"	August 5...	August 7	89	60	67.4	20	68.9	.....	80	89.8	0	0.0	80	89.8	9	10.1
8	"	"	"	160	61	38.1	89	88.0	.....	150	93.7	3	30.0	153	95 6	7	4.3
7	"	August 27	August 27	360	305	84.7	41	74.5	.....	346	96.1	0	0.0	346	96.1	14	3.9
8	"	"	"	310	239	77.0	62	87.4	.....	301	97.0	1	11.1	302	97.4	8	2.5
7	"	September 3. ..	September 3....	20	20	10.0	0	0.0	.....	20	100.0	0	0.0	20	10.0	0	0.0
8	"	"	"	34	28	82.3	1	16.7	.....	29	85 2	0	0.0	29	85.2	5	14.7
Total 7	"			1,615	856	53.0	237	31.2	.....	1,093	67.6	64	12.0	1,157	71.6	458	28.3
Total 8	"			1,609	739	45.9	357	41.6	.....	1,096	68.1	24	4.6	1,120	69 6	489	30.3
7	Picked	September 3....		91	64	70.3	27	29.6	13	78	85.7	2	15.3	80	87.9	11	12.2
8	"	"		216	170	78.6	84	38.8	59	195	90.2	7	33.3	202	93.5	14	6.4
Grand total 7				1,706	920	53 9	264	31 06	13	1,171	68 7	66	12 5	1,237	72.6	469	27.4
Grand total 8				1,825	909	49.8	441	40.61	59	1,291	70.7	31	5.8	1,322	72.6	503	27.5

Lime Experiment 2. Trees 9 (treated) and 10 (check).

9	Fallen	June 13, 20, 30	July 16	890	160	17 9	61	11.0		241	37 0	14	2.1	255	28.6	635	71 3
10	"		"	100	49	49.0	7	15.6		56	56.0	0	0.0	56	56.0	44	44.0
9	"	July 15	July 24	420	106	25.2	103	32.7		209	49.7	5	2.4	214	50.9	206	49.0
10	"		"	52	28	53.8	8	33.3		36	69.2	2	12.5	38	73.0	14	26.9
9	"	July 30	July 31	423	88	20.8	168	50.1		256	60.5	5	2.9	261	61.7	162	38.2
10	"		"	51	35	64.8	14	73.6		49	90.7	0	0.0	49	90.7	5	9.2
9	"	August 5	August 7	777	419	53.9	160	44.6		579	74.5	25	12.6	604	77.7	198	22.1
10	"		"	86	49	56.9	28	75 6		77	89.5	2	22.2	79	91.8	7	8.0
9	"	August 27	August 27	339	104	28.8	33	12.9		137	38.1	5	2.2	142	39.6	217	60.4
10	"		"	85	77	90.5	7	87.5		84	98 8	0	0.0	84	98.8	1	1.1
Total 9	"			2,869	877	30.5	545	27.3		1,422	49.5	54	7.7	1,476	51.4	1,393	48.5
Total 10	"			377	238	63.1	64	46.0		302	80.1	4	5.3	306	81.1	71	18.8
9	Picked	September 3	August 31	686	31	4.5	38	5.8		69	10.0	8	1.3	77	11.2	609	88.7
10	"		"	443	315	71.1	10	7.8		325	73 3	10	8.4	335	75 6	108	24.3
Grand total 9				3,555	908	25 5	583	22.0		1,491	41.9	62	3 0	1,553	43 6	2,002	56 3
Grand total 10				820	553	67.5	74	27.7		627	76.4	14	7.2	641	78.1	179	21 6
Grand total 7 and 9				5,261	1,828	34 7	847	19.2	13	2,662	50.6	128	4.9	2 798	53 0	2,471	46 9
Grand total 8 and 10				2,645	1,462	55.2	515	27.0	59	1,918	72.4	45	6.1	1,963	74.2	682	25.7

A SECOND CONTRIBUTION TO THE LIFE HISTORY OF THE CORN PLANT LOUSE (*Aphis maidis*, Fitch.)

By H. GARMAN.

In continuing the study of the life history of the corn plant louse, at the beginning of the summer of 1885 a large frame was erected out of doors and so enclosed as to exclude insects from without and to prevent those within from escaping. In this enclosed frame three hills of field corn were planted and on their appearance above ground one of them was stocked with a colony of *Lasius alienus*, Forst.,* the small ant which habitually attends the root form of this plant louse. The ants made themselves quarters about the roots of the corn, and on the 19th of July a number of wingless viviparous female lice, with their young and one pupa, were placed within reach of the ants and were at once carried to the roots of the corn by the latter. On the 22d of July other root lice, wingless and winged, were placed near the stocked plants and were also carried to the roots.

With a view to learning whether or not root lice would of themselves make their way to the roots of corn, on July 22d and subsequently many specimens were placed at the base of one of the hills not colonized with ants. They always disappeared, but could not be found afterwards on the roots. The plants with which they were placed continued to grow as well, as the third hill under cover, which from the first had not been disturbed, and at the close of the summer careful search did not disclose lice on the roots.

The injurious effect of the lice on the infested plants was soon noticeable in their smaller size and less vigorous growth. At various times during the summer the burrows of the ants along the roots were uncovered, revealing each time the presence of lice. From July 23d until the first of August winged lice came from these burrows and were sometimes found on the blades of corn, but more frequently on the inside of the enclosing cloth of the frame. These winged individuals showed no disposition to establish colonies on the blades of corn, but on the contrary seemed desirous of leaving the plants as soon as possible. All were viviparous females and in

*This species has been heretofore mentioned in these reports as *Lasius flavus*, on the strength of a determination made for us in 1882 by a distinguished student of American Formicidæ. Doubts arising as to the correctness of this specific name, especially as the habits of our species were very different from those of *L. flavus* as reported in the old world, specimens were sent, in 1885, to Dr. Aug. Forel, of Geneva, Switzerland, and the name here given rests on his authority.—S. A. F.]

several cases where confined upon the plants, although sometimes inserting the beak and feeding, they died with the ovaries filled with young. The migration of winged lice from the ground was observed at the same time in neighboring fields where, on the 27th of July, many of these winged lice, chiefly dead, were found on the blades. A careful search of the roots, made at the same time, showed that the root form was now rare in situations in which it had done most injury in the spring.

Root lice were observed on the enclosed corn until the latter part of August, but were not again uncovered until October 7, the ants in the meantime being constantly observed running in and out. On the morning of October 7, the infested plants were dug up carefully and carried in doors for careful examination, and upon one of the roots which had several times during the season been found to support plant lice was found a small colony of oviparous females, the only egg-laying examples of the species which up to the time had been seen. They bear a close resemblance to the more common viviparous female of the root form, as the following description will show:—

The Oviparous Female Aphis maidis [root form].—General color, dull green; body covered with a glaucous bloom. Above, head dusky, prothorax chiefly dusky, the three succeeding segments each with a median transverse dusky blotch, all the segments behind the prothorax with a marginal and submarginal series of dusky specks on each side. Below, head and prothorax dusky, two dark spots outside the coxa of the middle leg, a dusky line before the coxa of the hind leg, abdominal segments with two series of dusky specks on each side and a pair of dark spots before the cauda. Antennæ, two basal articles, third and fourth at tips, and fifth and sixth chiefly, dusky. Eye brownish red. Rostrum dusky. Anterior and middle legs with the coxæ, femora except at bases, tibiæ at tips, and tarsi except bases, dusky. Posterior leg, excepting the extreme base of the femur, black. Cornicles black. Cauda with black border. Body stout, its greatest width at about the middle. Outline of the front seen from above incurved medially. Antenna with first and second articles equal in length, the first stoutest; third article about equal in length to the fourth and fifth together, the latter nearly equal in length and similar in form; basal part of sixth article shorter than the distal part, about equal to the fifth in length. Cornicles short, not at all swollen at the middle. The limbs and cauda have the usual slight pubescence of members of the genus Aphis.

Length of body	2.27 mm.
Width of body	1.20 mm.
Antenna	.80 mm.
Cornicle	.20 mm.

Perfectly developed eggs taken from the ovaries are oval in shape, pale yellow in color, and measure about .73 mm.

In addition to the discovery of the oviparous female of the root form another interesting fact in the life history was observed during the season. A careful lookout was kept for any tendency of the plant lice, both within and outside the enclosed frame, to breed on

plants other than corn, and on the 30th of August indubitable *Aphis maidis* of the ærial form were found to be not uncommon in places on young grasses which later were found to be Panicum. After this date they were repeatedly found on this grass. All those examined from the grasses were apterous viviparous females and young.

On the Injurious Locusts of Central Illinois.

BY CLARENCE M. WEED.

One of the most notable entomological events of the year 1885, in Illinois, was the destructive outbreak of two common and widely distributed species of locusts, or grasshoppers as they are more familiarly known, the red-legged locust (*Pezotettix femur rubrum*) and the olive locust (*Pezotettix differentialis*), which resulted in much serious injury to various farm and garden crops, and caused no little apprehension concerning future attack in many farming communities. The region infested may be broadly indicated as the area between the fortieth and forty-second parallels of latitude, or included within a parallelogram having the eastern and western boundaries of the State for two of its sides, and horizontal lines passing through the central portion of Champaign county on the south and the northern boundary of DuPage county on the north for the other two. But the region of greatest injury was much more limited than this, being, as stated by Prof. Forbes in an article "On Some Illinois Locusts," published in the Crop Report of the Illinois Department of Agriculture, for August, 1885 "nearly circumscribed by a line running from the mouth of Rock River to LaSalle, thence down the Illinois Central Railroad to Bloomington, and from there to Quincy," nearly all the accounts of serious mischief coming from the vicinity of Galesburg and Peoria, in the triangular region between those points and the Illinois river to the southward of the former place. In the report just cited, correspondents record that the grasshoppers were so abundant as to cover the pastures in Bureau, DuPage, and Fulton counties; that oats were "injured to a considerable extent just before harvesting" in Grundy county; that "grasshoppers are in greater numbers than for twenty-five years" in Henry county; that oats are poor in Iroquois county, "the grasshoppers having cut off the heads of fully one third of the crop;" that the pests "have injured the oat crop some" in Kankakee county, as is the case in Livingston county, where, also, "the condition of pastures is not good, owing to the drouth and grasshoppers." From McDonough county the correspondent writes that grasshoppers are very numerous and are "injuring the corn to some extent;" while in McLean county "the pastures were doing well until the grasshoppers began to work on them." In Peoria county, according to the report, "the prospect for an average yield of corn is not encouraging, owing to the vast amount of replanting and the injury done by grasshoppers," while "oats have been injured in Rock Island county; and there was

"some complaint of grasshoppers damaging corn" in Stark county. Correspondents also state that the pests had injured oats "very much" in Tazewell county; that "oats were injured by grasshoppers" in Warren county, and, finally, that "the grasshoppers were very numerous and did some damage to meadows and oats in Woodford county."

HABITS AND LIFE HISTORY.

Prof. Forbes has summarized, in the article mentioned above, the life history of these species as follows:

"These locusts are single-brooded as far as observed; they hibernate in the egg, hatching in midsummer; pass through five successive moults, gaining their full size, and with this their wings, in August, and commence to lay their eggs in September. The females deposit these in the earth, boring cylindrical holes for the purpose with the abdomen, and laying the eggs in a symmetrical mass within the burrow thus formed. With the egg mass is extruded a quantity of mucus, which soon hardens and forms a sort of case or matrix, in which the eggs are imbedded. The upper part of the hole is also filled with this mucus. The female is commonly busied from two to four or five hours in the deposit of a single egg mass, and lays, ordinarily, from two to four such masses in different holes, upon different days, commencing this process of oviposition, as a rule, about a month after she has acquired her wings. After this process is completed, the exhausted females soon perish. They select by preference, for oviposition, hard and dry ground, roadsides and pastures being especially favorite localities. Meadows and pastures are commonly resorted to by the mature females, especially the latter, as the eggs seem not to be laid ordinarily on ground covered by luxuriant vegetation. I have never known them deposited in cultivated earth.

"The food habits of these locusts are extremely simple, and consist in eating nearly everything that comes in their way. They are quiet by night, and indeed, as they mature, they select elevated positions as roosts, climbing to the tops of stems of grass in meadows, to the tassels of the stalks in corn fields, and even deserting fields of low herbage if they can find more elevated roosting points near by. When very abundant, and when the weather continues dry, they occasionally swarm like the Rocky Mountain locust, but rarely flying continuously to any great distance, or indeed taking any definite course."

In many respects the outbreak of these locusts the past season is similar to that recorded as having taken place at varying intervals since the settlement of Illinois; the destruction thus caused in 1868–69 being especially noteworthy. It was probably due to the combination of a variety of local and meteorological causes favoring the undue development of these locusts, which are ordinarily kept below the danger line by their insect and other enemies. Even in the region indicated as infested, the destruction was largely local, the farmers of one county suffering serious loss, while the lands of their neighbors in the county adjoining were free from attack.

In the article above cited, Prof. Forbes states:

"The first decided injuries reported this year were to oats, which the grasshoppers commonly invaded when driven out of the meadows by the harvesting of the hay. This crop being already headed, the insects attacked it by climbing the stems and eating off the pedicels of the oats so that the grain dropped to the ground, many fields being thus almost entirely destroyed, and others reduced in yield from five, to ten or fifteen bushels per acre. In some cases the entire head was eaten off, and dropped to the ground. Considerable annoyance was occasioned in harvest fields by the grasshoppers eating the twine bands, so that the bundles fell apart. After the oats were harvested the pests frequently took refuge in adjacent corn fields, working at first around the borders of the fields, but later, in some situations, scattered almost uniformly through the entire area. Here a very serious damage was done, especially if the corn was a little late, by their eating off the silk at the tip of the young ear as fast as it fruited, and likewise eating out the stamens from the tassels, the necessary consequence being to prevent the fertilization of the grain and consequently to occasion the blasting of the ear. Some farmers in the regions worst infested have reported to me that their fields were entirely ruined, but commonly the principal mischief was confined to the ten or twenty outer rows. In gardens, potatoes, cabbages, raspberries, and strawberries have suffered materially, and in nurseries, the foliage upon the young stock had in many cases been completely eaten away."

In general little need be added to this account, but the following notes of a visit I made, under Prof. Forbes's direction, to a farm on which the grasshoppers were very numerous and caused serious injury, may be of interest as fairly representing the conditions on many other farms where the locusts were destructive. On November 25 I visited the farm of Mr. B. C. Davis, of French Grove, Peoria county, and found the destructive results of the grasshoppers' presence very apparent even at that time. The farm, consisting of 160 acres, had been cropped the past season about as follows: corn, 66 acres; oats, 20 acres; clover pasture, 40 acres; clover and timothy meadow, 30 acres; the remaining portion being utilized for gardens, yards, etc. Mr. Davis, who kindly did all in his power to aid the investigation, stated that the injury to corn was very great, as the locusts attacked it and began eating the silk before the pollen had fertilized the kernels, so that the latter did not "fill." Sixteen acres of the sixty-six yielded fifty bushels to the acre; the rest only twenty bushels per acre. There was no difference in the time of planting or methods of cultivation, the increased yield of the former portion of the field being due to the fact that the locusts did not reach it sufficiently early to cause serious injury. On many of the cobs to be found upon the injured acres there was not a single well developed kernel, and a large proportion of the ears consisted of stunted cobs bearing only a few dozen partially developed kernels. The injury to oats was equally serious, Mr. Davis stating that he lost 400 bushels from twenty acres because of the grasshoppers, which attacked half the field before it was cut; the yield on the

untouched portion being double that of the rest. Of the injury to clover Mr. Davis said that he had seventy acres in meadow and pasture, largely clover, and the loss occasioned by the locusts amounted to at least five dollars per acre. A forty-acre pasture on which the insects were driven from the oat field when the oats were cut was eaten close, and in many cases the growth was entirely killed, the attack necessitating feeding with other forage the stock pasturing upon it. The clover of the thirty-acre meadow was in the greater portion killed, and the timothy was badly injured.

The above statements of the damage caused by grasshoppers on Mr. Davis's farm in all probability fairly represent the then existing condition of many other farms in Peoria county. From a number of gentlemen who were at Mr. Davis's home at the time of my visit, I learned that in the whole region around French Grove serious depredations had taken place. Mr. M. P. Reed, an intelligent farmer residing in the vicinity, stated that he had forty acres of oats damaged to an extent equal to seven bushels per acre: a loss of 280 bushels. A separate piece of four acres, also belonging to Mr. R., bordered by pasture on one side and meadow on the other, was totally destroyed. Mr. Reed also mentioned a twenty acre field of oats belonging to Mr. Homer Tucker, that was so damaged that no attempt was made to harvest it. He added that the grasshoppers in the oats at the time of threshing, made such a horrible stench that it was sickening to measure; the oats that were threshed earliest being worst in this respect. Mr. Samuel Reed stated that some of his oats were more injured after they were in the shock than before. Another instance was reported, where, from twenty-five acres of oats, only one hundred and sixty bushels were harvested, the small yield being attributed to a visit from the locusts. Clover was also seriously injured on many farms. Mr. M. P. Reed, whose statements concerning injuries to oats have just been quoted, reported that a splendid stand of clover and timothy in a forty-acre field, which had been in oats, was destroyed, and a stand of clover belonging to Mr. Samuel Reed, which was as high as the stubble when the oats were cut, was so devastated that at the time of threshing not a green leaf could be seen.

ENEMIES.

Fortunately there are a considerable number of species of animals that depend, to a greater or less extent, upon grasshoppers for subsistence. Some of these are predaceous, others parasitic, but all combine in keeping the pests in check. Prominent among those efficient in this work are the species that live within or upon the eggs of the locusts, as the latter exist in that state for the longest period of their lives, and are also then the most helpless and susceptible to injury. The common blister beetles (*Epicauta*) live, so far as known, in their larval state, exclusively upon the eggs of locusts, and are thus of immense benefit to man. The adults of two species of these beetles, the margined blister beetle, (*Epicauta cinerea*) and the striped blister beetle (*E. vittata*) were found very abundantly by Prof. Forbes in Peoria and Knox counties late in September, and,

as indicated below, the larvæ were taken quite abundantly, destroying the locust eggs later in the season. Small red mites, which are frequently seen attached to the bodies of the mature locusts, are also of benefit, in that while young they suck the life-juices of the locusts, and, later, puncture their eggs and extract the contents. These were rather numerous in the infested regions. The larvæ of the common black ground beetles (*Carabidæ*) which are, to a great extent, carnivorous, also feed upon the eggs, and, as they are everywhere abundant, contribute not a little to lessening their numbers. Certain species of two-winged flies (*Diptera*) are also known to be parasitic upon the eggs as well as the adults, and there were indications that some of them, at least, were at work in Peoria and Knox counties the past season. The white hair-worms (*Mermis*), which also infest grasshoppers, were found by Prof. Forbes, in the summer, "unusually numerous in the sod," though he had not "seen any evidence that they appreciably diminished the number of grasshoppers."

The following account, as given in my notes, of the investigation of the situations in which the eggs were laid and the extent to which they had been destroyed during the autumn of 1885, on Mr. Davis's farm, may be of interest as indicating the positions from which the young locusts will emerge the coming season, and the condition in which the eggs were at the beginning of winter.

The first field examined was the pasture on which the locusts had been so numerous that a considerable portion of clover had been killed, root and branch. In searching for the eggs, which are deposited about an inch below the surface of the soil in masses or pods, each of which contains a number of eggs varying from a dozen to fifty or sixty or even a hundred, a short strip was plowed to a depth of about one inch and the sod thus inverted was broken up bit by bit, a careful record of the number of egg-masses found being kept, and the eggs themselves, together with any predaceous, parasitic, or other insects that were discovered, were bottled in alcohol. All facts that could have any bearing on the subject, such as situation in the field, the number and species of insect enemies, or the proportion of eggs destroyed, were also recorded. The first plowing on the highest portion of the pasture turned up about 27 square feet of sod, in which nine egg pods were found, a portion of them having been destroyed by insect enemies. In one of the pods was a living larva of one of the blister beetles (*Meloidæ*), which had already devoured about half of the eggs, and was rapidly making way with the rest. Several red mites, which are supposed to prey upon locust eggs, were found, as were a few of the predaceous larvæ of the *Caralidæ* or ground beetles. At the second plowing, 20 square feet were inverted, revealing four egg masses, two meloid coarctate larvæ, and two carabid beetles. Next, 15 square feet were overturned, seven egg pods being found, four of which had been destroyed; and one meloid coarctate larva was taken. Another strip of the same size as the last, midway between the highest and lowest part of the pasture, yielded six egg masses (one of which was destroyed) two red mites, and one meloid larva. The rest of the plowing was in the lowest portion of the field, which was well underdrained and perfectly dry. The soil here was black and loamy.

Eggs were quite abundant, and a smaller proportion had been destroyed than on the higher ground. One pod contained a living devouring carabid larva, with fragments of eaten eggs and other eggs as yet untouched. Three other larvæ of Carabidæ were here found, as also one meloid larva.

We next visited the upland meadow, consisting of about thirty acres of clover and timothy mixed. The grasshoppers had killed the first crop of clover and the roots were mostly dead, but the timothy was still alive. The egg masses were much less numerous in this field than in the pasture, and a greater proportion had been destroyed. Probably oviposition would here be more difficult than in the pasture, because the ground near the surface was more penetrated with the coarse roots and stalks of the timothy and clover; but the principal reason for the greater scarcity of the eggs is, as suggested by Professor Forbes, in all probability to be found in the fact that the insects would naturally have left this field on account of the cutting of the hay before the time of oviposition. A considerable surface of the meadow was plowed and only fifteen or twenty egg masses were found, all but four of which had been more or less destroyed. Several larval and imago Carabidæ were collected, as also one coarctate larva of Epicauta, and red mites were common. A number of dipterous larvæ, which may prey upon the eggs, were also found. The reasons for the comparatively greater destruction in this field are probably that the surface above the egg masses was more porous, allowing enemies easier access, and that the scarcity of the eggs necessitated the concentration of the destructive forces.

SITUATION OF THE EGGS.

In order to determine whether the eggs were ever laid in corn fields, a point of considerable importance in considering methods of destruction, a thorough search was made in various parts of the corn fields where the locusts had been destructive, resulting in the discovery of a single egg mass which had been destroyed by enemies. Mr. Davis stated that he had seen an instance where a grasshopper was depositing eggs in the corn field, but he believed it to be a rare occurrence. Hence it seems safe to conclude that practically the number of eggs deposited in corn fields is not sufficient to be of any account. An oat field on which the locusts had been very numerous, though leaving it soon after the crop was harvested, was also examined, but no eggs were found.

IN KNOX COUNTY.

On November 26, acting under Prof. Forbes's directions, I visited the farm of Mr. Sisson, at Galesburg. The farm consists of 320 acres of slightly rolling land, mainly devoted to pastures, meadow, corn, and oats. The grasshoppers were very numerous during the summer, injuring oats to an amount estimated at 20 bushels per acre. The stand of clover in the oat stubble was also considerably damaged, and in spots entirely killed. Corn was injured somewhat, especially along the edges, but the damage was much less serious

than at French Grove. The corn field was examined for eggs, but none were found. On the upland meadow twenty-four egg masses were taken during a search of about one hour, in which Mr. Sisson kindly rendered efficient aid, twenty of which were parasitized and completely destroyed. In the earth about the parasitized masses, considerable numbers of dipterous pupæ were found, probably from the locust eggs. Some of these were put in a breeding cage and it is hoped that the adult flies may be obtained the coming season. A few dipterous larvæ similar to those of *Anthomyia* were also taken, and red mites were rather common.

DESTROYING YOUNG GRASSHOPPERS.

In the first report of the United States Entomological Commission, a Commission appointed to investigate the life history and methods of preventing the ravages of the Rocky Mountain locust, Dr. Riley, in considering the destruction of the young or unfledged locusts, writes that experience has firmly established the fact "that with proper means, efforts, and co-operation, the farmer in the more settled portions of the country liable to their injury, may successfully cope with them; that, in short, he can protect his crops against them with about as little labor and expense as he must annually employ to protect most of these same crops from weeds." As the life histories of the two species at present threatening to become seriously destructive in certain portions of Illinois are not essentially different from that of the one just mentioned, and as they succumb to the same destructive agencies as have been successfully employed with little expense in the West, it becomes the duty of every farmer in the infested regions to watch closely such situations on his farm as are likely to be stocked with locust eggs for the hatching of the young, and to immediately apply such remedial measures as seem best adapted to each case. Negligence in this respect would be almost criminal, and hearty individual and united efforts are earnestly advised.

In the report above cited the methods of destroying young locusts are classified thus: 1. Burning. 2. Crushing. 3. Trapping. 4. Catching. 5. Use of destructive agents. By the first method old hay or straw is scattered "over or around the field in heaps and windrows, into which the locusts for some time after they hatch may be driven and burned." When the weather is cold and damp the locusts will seek the shelter of the hay or straw, and may easily be burned before escaping. This method is well adapted to upland pastures, where the eggs have been deposited in greatest numbers.

For the successful application of the second method mentioned above, it is necessary that the surface of the fields on which it is applied be smooth and hard. Here, again, the upland pastures present unusually favorable opportunities for successful work. Dr. Riley states that "Where the surface of the ground presents this character, heavy rolling can be successfully employed, especially in the mornings and evenings of the first eight or ten days after the newly hatched young have made their appearance, as they are generally sluggish during these times and huddle together until after sunrise.

It it also advantageously employed during cold weather at any time of the day, since the young, when the temperature is low, seek shelter under clods, etc."

Under the third head given above, that of trapping, Dr. Riley includes ditching, trenching, and the use of pans covered with coal oil, or coal tar. In the first two processes ditches or trenches are dug in favorable situations, into which the young insects are driven. Probably the use of pans covered with coal oil will be as simple and advisable a method, unless we except that of rolling, as can be employed in the district under consideration. Dr. Riley has described a small pan well adapted for the purpose, as follows: "A good and cheap pan is made of ordinary sheet iron, eight feet long, eleven inches wide at the bottom, and turned up a foot high at the back and an inch high at the front. A runner at each end, extending some distance behind, and a cord extending to each front corner, completes the pan, at a cost of about $2.50.

"We have known from seven to ten bushels of young locusts caught with one such pan in an afternoon. It is easily pulled by two boys, and by running several together in a row, one boy to each outer rope, and one to each contiguous pair, the best work is performed with least labor. Longer pans, to be drawn by horses, should have transverse partitions to avoid spilling the liquid; also more runners. The oil may be used alone, so as to just cover the bottom, or on the surface of water; and the insects strained through a wire ladle. When the insects are very small, one may economize in kerosene by lining the pan with saturated cloth, but this becomes less efficient afterwards, and frames of cloth saturated with oil do not equal the pans."

The use of destructive agents, such as London purple, Paris green, and the like, has not been attended with any very great success when applied on a large scale. But for limited areas, doubtless a great many of the locusts may thus be easily destroyed. Dr. Riley has recently published a description of a mixture which was successfully employed last year in California. The mixture consists of "arsenic, sugar, bran, and water, the proportions being one part, by weight, of arsenic, one of sugar, and five of bran, to which is added a certain quantity of water. The arsenic and bran are first mixed together, then the sugar is dissolved in water and added to the bran and arsenic, after which a sufficient quantity of water is added to thoroughly wet the mixture. About a teaspoonful of this mixture is thrown upon the ground at the base of each tree or vine (in gardens and orchards) and left to do its work. The poison works slowly, seldom killing its victim within eight or ten hours after it has been eaten."

In some situations it might be advisable to harrow the surface thoroughly as early in spring as possible, to expose the eggs to the air and to their numerous insect and other enemies.

CONCLUSION.

From the data now (Feb. 23) at hand, it does not seem safe to attempt to foretell to what extent the locusts may prove injurious

the coming season. We know that their enemies are now present in the devastated fields, that the long, warm autumn and open winter have been favorable for the destruction of the eggs, and that at the beginning of winter a considerable percentage had been destroyed. But as an immense number of eggs have doubtless been deposited, even should only a small proportion hatch, the locusts would be sufficiently numerous to stock the infested regions to an extent equal to, or greater than that of last year. The percentage escaping will probably depend somewhat upon the weather during the present spring and early summer. We do know, however, the situations in which the eggs have been deposited, and consequently the places where the young locusts will first appear; viz., upland pastures and meadows, and along roadsides and hedges, but probably never to any practical extent in fields cultivated the previous season, and then planted to corn, oats, and similar crops; unless perhaps there should have been a growth of young grass or clover to attract the egg-laden females late in autumn. Hence if a careful watch for the hatching of the young locusts is kept on these situations, and remedial measures, such as the use of the flat kerosene pans, rolling, etc., be at once applied, the insects may be destroyed at comparatively little expense before they migrate to the neighboring cropped fields.

PARTIAL ECONOMIC BIBLIOGRAPHY OF INDIAN CORN INSECTS.

By Thomas F. Hunt.

[The following bibliographical notes and list were intended as a basis for a discussion of the insects injurious to Indian Corn in Illinois; but circumstances explained on another page having prevented the publication of this monograph, this paper is printed as the best available present substitute.

A complete bibliography of the subject was unnecessary for the purpose intended; but it is believed that so much as is here given, includes all the published facts of economic importance relating to the corn insects. S. A. F.]

The following books, periodicals, and newspapers, were scanned in preparing the list of references to the insects affecting Indian Corn:

Harris's Insects Injurious to Vegetation, 3d ed.

Fitch's Reports on the Insects of New York, Vols. I–XIV.

Reports of the U. S. Commissioner of Agriculture for the years 1862–1884.

Riley's Reports on the Insects of Missouri, Vols. I–IX.

Reports on the Injurious Insects of Illinois, I–XIV.

Packard's Guide to the Study of Insects.

Packard's Reports on the Insects of Mass., I–III.

Lintner's Reports on the Insects of N. Y., I–II.

Reports U. S. Ent. Commission, I–III.

Reports of Ent. Soc. of Ontario, I–XV.

Practical Entomologist, I–II.

American Entomologist, I–III.

Canadian Entomologist, I–XVII.

Report Kansas State Board Agric., 1872–1882.

Report Maine State Board Agric., 1872–1878.

Report Michigan State Board Agric., 1872–1884.

The Prairie Farmer, Chicago, 1843–1852 and 1862–1867.

The Cultivator, 1844–1863.

The Cultivator and Country Gentleman, 1865–1883, except 1881.

Miscellaneous articles in the Proceedings of the American Philosophical Society, in the Proceedings of the Philadelphia Academy of Natural Sciences, in the Proceedings of the Entomological Society of Philadelphia, in the Transactions of the American Entomological Society, in Hayden's Geological and Geographical Survey of the Territories, in Comstock's Report on Cotton Insects, in office newspaper scrap-books, and in other books not enumerated, were also freely drawn upon for data.

Order HYMENOPTERA.

Family Formicidæ.

1. The Small Yellow Ant.

(*Solenopsis fugax*, Latr.)

1798. Latreille, P. A.—*Formica fugax.* Ess. sur l'Histe des Fourm. de la France, p. 46. Original description.

1802. Latreille, P. A.—Idem. Hist. Nat. des Fourm. p. 265. Description male and female.

1834. Forbes, S. A.—*Solenopsis fugax.* 13th Rep. St. Ent. Ill., pp. 112, 113. Description of imago. Injuries to young Indian Corn—feeding upon the kernel and thereby stunting the growth of the plant.

2. Solenopsis molesta, Say.

1835. Say, Thomas.—*Myrmica molesta.* Bost. Jour. Nat. Hist. I., 294. Complete writings, II., 737. (Description of new North American Hymenoptera and observations on some already described.) Original description. Sometimes eats vegetable food.

1865. Fitch, Asa.—Idem. Trans. N. Y. St. Agr. Soc., 1865, p. 133. Injuring young Indian Corn by gnawing blades.

Order LEPIDOPTERA.

Family Bombycidæ.

3. The Arge Tiger-Moth.

(*Arctia arge*, Drury.)

1770. Drury, Drew.—*Bombyx arge.* Illustr. Nat. Hist. I., 35, pl. XVIII., fig. 2. Original description.

1797. Smith, J. E.—*Phalæna dione.* Nat. Hist. Lep. Ins. Ga. p. 125, tab. 63.

1842. HARRIS, T. W.—*Arctia arge*. Rep. Mass. Insects. General description of moth and larva. Moth taken from May 20 till middle of July. Caterpillars appear sometimes in great numbers in October. Eat leaves of plantain and other herbaceous plants. Sometimes very destructive to INDIAN CORN in Southern States.

1861. CLEMENS, B.—*Arctia dione*. Proc. Acad. Nat. Sci. Phila. 1860, p. 528. Description of moth. N. Y., Mass., Ga., Ill.

1862. HARRIS, T. W.—*Arctia arge*. Insects injurious to vegetation, 3d ed. p. 346. (See under 1842.)

1862. MORRIS, J. G.—*Arctia dione*. Synop. Lep. N. A., Appendix, p. 340. Description of moth and larva. U. S.

1863. SAUNDERS, W.—Idem. Synop. Can. Arctiidæ p. 7.

1864. PACKARD, A. S., Jr.—*Arctia arge*. Proc. Ent. Soc. Phila. III., p. 118. (Synopsis of the Bombycidæ of the U. S.) Synonymy and bibliography. In Massachusetts this species is not infrequent, and becomes more abundant southward.

1873. LINTNER, J. A.—Idem. Rep. N. Y. St. Cab. N. H. XXIII., p. 193. Larva collected Feb. 23, in N. Y.

1874. LINTNER, J. A.—Idem. Rep. N. Y. St. Cab. N. H. XXVI., p. 179. Imago taken July 28, 1872.

1875. SNOW, F. H.—Idem. Trans. Kan. Acad. Sci. IV., p. 38. Not common in Kansas. Feeds upon plantain.

1878. FRENCH, G. H.—Idem. 7th Rep. St. Ent. of Ill. p. 182. General description of moth and larva. Food plants, plantain and INDIAN CORN.

1881. MARTEN, JOHN.—Idem. 10th Rep. St. Ent. of Ill. p. 115. General description of larva. Feeds on plantain and INDIAN CORN.

COQUILLET, D. W.—Idem. 10th Rep. St. Ent. Ill. p. 170. Specific description of larva. Feeds on evening primrose. Sept. to May.

4. THE SALT MARSH MOTH.

(*Leucarctia acræa*, Drury.)

1797. SMITH, J. E.—*Phalæna acria*. Nat. Hist. Lep. Ins. Ga. p. 133, tab. 67.

1816. HUBNER, JACOB.—*Estigmene acria*. Samml. Exot. Schm Bd. 2, pl. 191, no loc.

1823. HARRIS, T. W.—*Arctia pseuderminea*. Mass. Agr. Rep. and Journ. p. 322, pl. 1. Description of larva and moth. Life history and habits. Very destructive to grasses in salt marshes about Boston. Eggs laid in middle of June. Hatch in seven or eight days. Larvæ attain full size in

seven weeks; then become very voracious and "begin to run," devouring everything in their progress—INDIAN CORN, garden vegetables, etc. Soon change to chrysalids and winter thus.

Remedies:—Cut grass early in July and burn meadows in March.

1860. MORRIS, JOHN G.—*Spilosoma acria.* Synopsis Lep. N. A., Appendix, p. 342. Description of moth and larva.

1861. CLEMENS, B.—*Spilosoma acrea.* Proc. Acad. Nat. Sci. Phila. 1860, p. 531. Description of moth.

1862. HARRIS, T. W.—*Arctia acræa.* Insects injurious to vegetation, p. 351, fig. 169. Destructive to grasses in salt marshes about Boston, July and August. Feed in corn fields and gardens. Change to chrysalids in August and emerge June following. Middle and Southern States two broods annually. Destructive at irregular periods. Description of moth and larva. Mow marshes early and burn stubble following March.

1864. PACKARD, A. S., Jr.—*Spilosoma acræa.* Proc. Ent. Soc. Phila., III., 125. (Synopsis of the Bombycidæ of the United States.) Synonymy and bibliography.

1869. PACKARD, A. S., Jr.—*Leucarctia acræa.* Guide to the Study of Insects, p. 286. Caterpillar very injurious at times by its great numbers.

1875. SNOW, F. H.—Idem. Trans. Kan. Acad. Sci., IV., 38. Common in Kansas. Found feeding upon beet leaves.

1878. FRENCH, G. H.—Idem. 7th Rep. St. Ent. Ill., p. 79, 183. P. 79, widely distributed. Eats freely tender leaves of garden vegetables, field grains, etc. Description of larva and moth. Natural history. Remedy; burn stubble. P. 183, specific description of moth and larva. Food plants; cultivated plants, weeds, and grasses. Two broods. Checked by parasites. Hand-picking when numerous.

1881. COQUILLET, D. W.—Idem. 10th Rep. St. Ent. Ill., p. 170. Specific description of larva. Feeds on rag-weed, June to October.

5. THE YELLOW BEAR.

(*Spilosoma virginica*, Fab.)

1852. HARRIS, T. W.—*Arctica virginica.* Insects Injurious to Vegetation, p. 349. Feeds on leaves of INDIAN CORN, grasses, and herbaceous plants generally. Description of moth and larva. Larva—June to October. Moth emerges May and June. Hand-picking suggested.

1857. FITCH, ASA.—*Spilosoma virginica.* Third Rep. Ins. N. Y., p. 82, No. 125. Brief description of moth, larva, and pupa. Food plants.

1861. CLEMENS, B.—Idem. Proc. Acad. Nat. Sci. Phila. 1860, p. 531. Description of moth.

MORRIS, JOHN G.—Idem. Synop. Lep. N. A., Appendix, p. 342. Description of moth and larva.

1863. SAUNDERS, W.—Idem. Synop. Can. Lep., p. 14.

1864. PACKARD, A. S., JR.—Idem. Proc. Ent. Soc. Phila., III., 125. (Synopsis of the Bombycidæ of the United States.) Synonymy and bibliography.

1869. PACKARD, A. S., JR.—Idem. Guide to the Study of Insects, p. 287. Brief description of imago.

1870. RILEY, C. V.—Idem. Amer. Ent., II., 272. General description of moth and larva. Habits and life history. Moths appear May 1. Larva from June to October. Two-brooded. Winter in chrysalis state. Feeds on INDIAN CORN and almost any plant with tender leaves. Checked by five distinct parasites.

1871. RILEY, C. V.—Idem. 3d Annual Rep. St. Ent. of Mo., p. 68. (See under 1870.)

1873. LINTNER, J. A.—Idem. 23d Rep. N. Y. St. Cab. N. H., p. 193. Moth collected May 7 and June 19 in N. Y.

1874. LINTNER, J. A.—Idem. 26th Rep., N. Y. St. Cab. N. H. p. 179. Moth collected May 30 to June 29, 1873.

1875. SNOW, F. H.—Idem. Trans. Kan. Acad. Sci. IV., p. 38. Common in Kansas. Feeds upon leaves of INDIAN CORN, peas, beans, plantain, grasses, and sometimes grape, currant, and gooseberry.

1878. FRENCH, G. H.—Idem. 7th Rep. St. Ent. of Ill., p. 183. Specific description of larva and moth. Found from June to October on peas, beans, cabbages, INDIAN CORN, grapes, etc. Hand-picking suggested.

1881. SAUNDERS, W.—Idem. Ann. Rep. Ent. Soc. Ont. for 1880, p. 21. General description of moth and larva. Habits and life history. Two-brooded. Winters in pupa state. Moths appear in May. Checked by several parasites.

MARTEN, JOHN.—Idem. 10th Rep. State Ent. Ill., p. 116. Specific description of larva. Two-brooded. Food plants; butternut, lilac, peas, beans, gooseberry, sorrel, convolvus, INDIAN CORN, currant, sunflower, smartweed, plantain, verbena, geranium, etc.

COQUILLET, D. W.—Idem. 10th Rep. St. Ent. of Ill., p. 169. Specific description of larva. June to November.

6. Saddle-Back Caterpillar.

(*Empretia stimulea*, Clemens.)

1861. Clemens, B.—*Empretia stimulea.* Proc. Acad. Nat. Sci. Phila., 1860, p. 159. Original description of moth and larva. Spines produce painful sensation. On a great variety of plants: fruit-trees, rose, Indian corn.

1862. Morris, J. G.—Idem. Synop. Lep. N. A., p. 130. Description of moth and larva. Spines of horns produce painful sensation. On a great variety of plants: fruit-trees, the rose, Indian corn, etc.

1864. Packard, A. S., Jr.—Idem. Proc. Ent. Soc. Phila. III., 340. (Synopsis of the Bombycidæ of the United States.) Bibliography. Conn. N. Y.

1868. Walsh and Riley.—Idem. Amer. Ent. I., 40. Stinging sensation produced by spines of larva.
Walsh and Riley.—Idem. Amer. Ent. II., 32, 59. P. 52, derivation of name. P. 59, figured.

1869. Packard, A. S., Jr.—Idem. Guide to the Study of Insects, p. 289, pl. vii, fig. 1; 1a, larva. Brief description of moth and larva. Moth appeared June 18. Larva feeds on raspberry.

1875. Snow, F. H.—Idem. Trans. Kan. Acad. Sci. IV., 39. Seen only as a larva. Rare. Feeds upon the pear.

1878. French, G. H.—Idem. 7th Rep. St. Ent. Ill., p. 187. Description of moth and larva. Spines on its horns are poisonous. Feeds on great variety of plants, including fruit-trees, rose, and Indian corn.

1881. Marten, John.—Idem. 10th Rep. St. Ent. Ill., p. 117. Specific description of larva. Food plants: fruit-trees, rose, and Indian corn.

7. The Io Moth.

(*Hyperchiria io*, Fab.)

1797. Smith, J. E.—*Phalena io.* Nat. Hist. Lep. Ins. Ga., p. 97, tab. 49.

1835. Harris, T. W.—*Saturnia io.* Cat. Ins. Mass.

1842. Harris, T. W.—Idem. Rep. Ins. Mass., p. 284. General description of moth, larva, and cocoon. Larva, June to September. Furnished with spines. Winters in chrysalis state. Moths emerge during June and July. Feeds on leaves of Indian corn, clover, sassafras, dogwood, elm, and balsam poplar.

1856. Fitch, Asa.—Idem. Third Rep. Nox. Ins. N. Y., p. 61. Description of larva. Moths appear in June. Wild black cherry and thorn. Eat leaves from end of limbs.

1862. Harris, T. W.—Idem. Insects Injurious to Vegetation, pp. 393-397. 3d ed. figs. 183, 191, 192, larva; 190, pupa; 189, cocoon. (See under 1842.)

MORRIS, JOHN G.—Idem. Synopsis Lep. N. A., p. 220. Description of moth and larva. Cocoon spun between several dry leaves. Feeds on sassafras, dogwood, and poplar. United States.

1864. PACKARD, A. S., Jr.—*Hyperchiria varia*. Proc. Ent. Soc. Phila. III., 384. (Synopsis of the Bombycidæ of the United States.) Synonymy and bibliography. Reason for using *varia* instead of *io*.

1869. PACKARD, A. S., Jr.—Idem. Guide to the Study of Insects, p. 299. Brief description of imago, larva, and pupa. Very harmful to INDIAN CORN and cotton southward.

1873. LINTNER, J. A.—*Hyperchiria io*. 23d Rep. N. Y. St. N. H., pp. 189, 193. Moths collected July 9 and September 23. Larvæ collected July 15 and September 16 in N. Y.

1874. LINTNER, J. A.—Idem. 26th Rep. N. Y. St. Cab. N. H., p. 180. Moth collected June 12, 1872.

REED, E. B.—*Saturnia io*. Canadian Entomologist, Vol. VI., 227. Description of moth and larva. Difference of sexes. Life history and habits. Caterpillars gregarious. June to September. Food plants numerous: INDIAN CORN, clover, choke cherry, etc.

1875. REED, E. B.—Idem. Rep. Ent. Soc. Ont. 1874. pp. 11-13. Figs. 1, 2, 3, and 4. (See under 1874.)

SNOW, F. H.—*Hyperchiria varia*. Trans. Kan. Acad. Sci. IV., 41. Not common in Kansas. Feeds upon false indigo, wild cherry, willow, poplar, hop-vine, and INDIAN CORN.

1878. FRENCH, G. H.—*Hyperchiria io*. 7th Ann. Rep. St. Ent. Ill., p. 195. Description of moth. Food plants: INDIAN CORN, sassafras, locust, willow, etc.

1880. SAUNDERS, W.—*Saturnia io*. Rep. Ent. Soc. Ont., 1879, p. 75, figs. 46, 47, and 48. Description of moth and larva. Caterpillars gregarious. Pupate on ground among loose leaves and rubbish. Common in many quarters.

1881. MARTEN, JOHN.—*Hyperchiria io*. 10th Rep. St. Ent. Ill., p. 127, fig. 40. Description of larva. Feeds on INDIAN CORN, clover, currant, apple, and foliage of many trees.

COQUILLET, D. W.—Idem. 10th Rep. St. Ent. Ill., p. 169, fig. 64. Description of larva. June to September.

Family NOCTUIDÆ.

8. THE SMEARED DAGGER.

(*Apatela oblinita* Sm. and Abb.)

1797. ABBOTT, JOHN.—*Acronycta oblinita*. The Nat. Hist. of the Rarer Lep. Ins. of Ga., p. 187, pl. 94. Original description.

1852. GUENEE, A.—Idem. Nat. Hist. of Insects I., 49. Specific characters of imago and larva. Moths appear in April. Common in N. A.

1870. RILEY, C. V.—Idem. Amer. Ent., II., 275. Food plants: grape, smartweed, and a number of other plants.

RILEY, C. V.—Idem. 3d Rep. St. Ent. Mo., p. 70. Descriptions and figures of imago, larva, and pupa. Life history. Description of three parasites. Feeds on cotton, asparagus, peach, apple, and willow.

1873. LINTNER, J. A.—Idem. 23d Rep. N. Y. St. Cab. N. H., p. 194. Larva on Polygonum. September 12 in N. Y.

SAUNDERS, W.—Idem. Rep. Ent. Soc. Ont. 1872, p. 23, fig. 13. Description of imago and larva. Pupates in September. Moths emerge in June. Feeds on strawberry, raspberry, Lombardy poplar, smartweed, peach, apple, and willow. Three parasites mentioned. Remedy, hand-picking.

1874. LINTNER, J. A.—Idem. 26th Rep. N. Y. St. Cab. N. H., p. 180. Larva on Polygonum September 1, 1872.

1875. GENTRY, THOMAS G.—Idem. Proc. Phila. Acad. Nat. Sci., 1875, p. 24. Certain larvæ did not spin cocoons. Supposed to be due to deficient nutrition. Feed upon smartweed (*Polygonum pennsylvanicum.*) October.

SNOW, F. H.—Idem. Trans. Kan. Acad. Sci. IV., 43. Common in Kansas. Food plants.

1878. FRENCH, G. H.—Idem. 7th Rep. St. Ent. Ill., p. 201. Description of imago and larva. Larva occurs frequently during June and August or September. Feeds on smartweed, apple, and grape.

1881. MARTEN, JOHN.—*Apatela oblinita.* 10th Rep. St. Ent. Ill., p. 131, fig. 43. Description of larva. Found in June, August, and September on smartweed, apple, grape, and willow.

COQUILLET, D. W.—*Acronycta oblinita.* 10th Rep. St. Ent. Ill., p. 170, fig. 66. Description of larva. Feeds on smartweed, hazel, and INDIAN CORN. June to October.

1884. FORBES, S. A.—*Apatela oblinita.* 13th Rep. St. Ent. Ill., p. 82, pl. VI, fig. 3. Summary of published facts.

CUTWORMS.

1842. HARRIS, T. W.—Cutworms. Rep. Mass. Ins. Habits, injuries, and natural history of cutworms. Five species described. Various remedies proposed: collecting given as the only effectual one.

1845. DRUMMOND, ZA.—Idem. The Cultivator, 1845, p. 122. Writes from Virginia that his INDIAN CORN has never suffered from any kind of worms when the land has been thoroughly plowed in winter; but that it has always suffered on rich ground not plowed in winter.

1852. PRAIRIE FARMER, XII., 59.—Fall Plowing for Insects. Suggests that fall plowing destroys cutworms by destroying the food necessary for their development in early spring.

1856. RISLEY, WM.—Cutworms and their Destruction. The Cultivator, 3d series, IV., 145.

FITCH, ASA.—Cutworms. Rep. N. Y. Insects, II., 310–318. Severing the young stalks of INDIAN CORN, by night, at or near the surface of the ground. A thick, cylindrical, pale dull-colored worm, an inch or more in length. Popular ignorance respecting cutworms. Their life history and habits. Different kinds. Five larvæ described and three imagos, but their relations not stated. Natural enemies: crows, predaceous insects. Abundant seed recommended. Supposes cutworms to come from surrounding fields to the places where they are noticed, and hence advocates making a deep furrow around field or garden.

FITCH, ASA.—Idem. The Cultivator, 3d series, IV., 115. (Same as above.)

1862. HARRIS, T. W.—Idem. Insects Injurious to Vegetation, 3d ed., pp. 441–451. (See under 1842.)

1863. FITCH, ASA.—Idem. 9th Rep. N. Y. Insects, pp. 804–817. Early notices and records of their injuries. Ill success in rearing them. Young worms in autumn. Plowing to destroy them. Their habit of severing young plants; habits of different species. Their destruction by larvæ of *Calosoma calidum*.

1864. WARDER, J. A.—Idem. (Paper read before Cincinnati Hort. Soc.) Prairie Farmer, new series, XIII., 341. Remedial agencies.

RILEY, C. V.—The Cutworm. Prairie Farmer, new series, XIII., 169. Gives briefly their general life history. Does not believe plowing useful in destroying them.

1865. RILEY, C. V.—Idem. (From Rep. U. S. Dept. Agriculture, April and May, 1865.) Prairie Farmer, new series, XV., 483. Instance of efficacious use of salt by the Commissioner of Agriculture. Said to be fatal to cutworms on account of its effect upon their skin.

1866. WALSH, B. D.—Cutworms. Prac. Ent., I., 85–86. Defines the use of the term cutworm. Plants attacked. Seven species mentioned, and an account of injuries done by cutworms, especially to fruit trees, and remedies for the same.

1867. TOWNLEY, JOHN.—Idem. Prac. Ent., II., 64–66. Injuries done to buds and foliage of trees by cutworms. Remedies proposed. Sugaring with poisoned molasses suggested by Walsh.

RILEY, C. V.—A Chapter on Cutworms. Prairie Farmer, XIX., 413–414. Gives an account of their injuries to fruit trees and gives specific characters of one moth and three larvæ.

1869. RILEY, C. V.—Cutworms. 1st Rep. St. Ent. Mo., pp. 67–91. Gives natural history and descriptions of twelve distinct species. Natural enemies; parasites and predaceous insects. Collecting recommended. Fall plowing, to be efficacious,

must be done late. Remedies: ashes, lime, salt, etc. Experimenters generally forget that there is a period in the life of these worms when they disappear in the earth, and anything applied just before this happens, is sure to be heralded as a perfect remedy.

1872. COLES, Isaac.—Cutworms in Corn. Country Gent., XXXVII., 339. Sends specimens of cutworms to the editor with statement that they had almost entirely destroyed a field of INDIAN CORN, from one to five or six being in proximity to a hill, and enveloped in a web. Editor supposes them to *Hadena arctica*, Boisd.

1874. L. B.—Treatment of Cutworms. The Country Gent. XXXIX., 275. Writes from Maryland that he seldom finds cutworms destructive on fall or early spring plowing. Whenever they are destructive, he waits till they pupate and then replants.

1877. FERNALD, C. H.—Cutworms. Rep. Me. St. Board of Agriculture, 1877, pp. 62–65. Gives a brief account of habits, and an extended one of an attack upon a cutworm by a wasp (Sphex). States that for those which attack INDIAN CORN, digging up and killing is the best remedy.

1880. BOWLES, G. J.—Canadian Cutworms. Rep. Ent. Soc., Ont., 1879, pp. 38–46. Description and natural history of twelve species given, mostly after Fitch, Harris, and Riley. Abundance in Canada. Natural enemies, predaceous insects.

1885. RILEY, C. V.—Cabbage Cutworms. Rep. Com. Agr., 1884, pp. 289–300. Plates II and III. Eight species described and life history and habits given. Remedies for cutworms as cabbage pests.

9. SPOTTED CUTWORM.

(*Agrotis c-nigrum*, Linn.)

1767. LINNE, CARL VON.—*Noctua c-nigrum*. *Systema Naturæ*. 12th ed., Tome I., Part II., 852, No. 162. Original description.

1796. HUBNER JACOB.—SAMML. Europ. Schmett, p. III. Original description of larva.

1852. GUENEE, A.—*Noctua c-nigrum*. Spec. Gén. Lép. V.—Noct. I., 328. Bibliography. Brief description of imago. North America.

1873. LINTNER, J. A.—*Agrotis c-nigrum*. 23d Rep. N. Y. St. Cab. N. H., p. 194. Imago collected in N. Y. June 23.

1875. SNOW, F. H.—Idem. Trans. Kan. Acad. Sci. IV., 43. Not common in Kansas.

1878. FRENCH, G. H.—Idem. 7th Rep. St. Ent. Ill., pp. 89, 202. Specific characters of imago and general character of larva. Southern part of State. Larvæ change to chrysalids May 1. Observations on life history. Two-brooded or more.

1881. MARTEN, JOHN.—Idem. 10th Rep. St. Ent. Ill., p. 132. Description of larva. Feeds on grass, vegetables, pear-and maple-trees in March and April.

COQUILLET, D. W.—Idem. 10th Rep. St. Ent. Ill., p. 184. Description of larva. Feeds on grass. Found throughout the year.

1882. COQUILLET, D. W.—Idem. 11th Rep. St. Ent. Ill., p. 51. Abundance compared with army worms, as one to eight. Description of larva. Life history. Two-brooded. Moths June and September.

1883. RILEY, C. V.—Idem. 3d Rep. U. S. Ent. Com., p. 135. Large numbers of larvæ among army worms, in the evident proportion of about one cutworm to five army worms.

1885. LINTNER, J. A.—Idem. Cutworms, p. 6. Destructive to INDIAN CORN.

10. THE DINGY CUTWORM.

(*Agrotis subgothica*. Haw.)

1810. HAWORTH, A. H.—*Agrotis subgothica*. Lep. Britain. (*Teste* Lintner.) Original description.

1852. GUENEE, A.—*Agrotis jaculipera*. Sp. Gen. Lep. V., Noct. I., 262. Description of imago. North America, Canada. Seems very common.

1869. RILEY, C. V.—Idem. Rep. St. Ent. Mo. I., 82. Specific characters of imago, chrysalis, and larva. Injuries in Northern Illinois. Moths, September.

1873. GROTE, A. R.—*Agrotis subgothica*. Bul. Buf. Soc. Nat. Sci. I., 100. (*Teste* French.) Synonymy.

1874. LINTNER, J. A.—Idem. 26th Rep. N. Y. St. Cab. N. H., p. 180. Imago collected in N. Y. July 21 and 30.

1875. SNOW, F. H.—Idem. Trans. Kan. Acad. Sci. IV., 43. Very abundant and very destructive in Kansas.

1878. FRENCH, G. H.—Idem. 7th Rep. St. Ent. Ill. pp. 89, 204. P. 89, distinguishing marks of imago and larva. P. 204, description of imago and larva. Atlantic district to Colorado. Larva September to July. Reported destructive to gardens in the vicinity of Rockford.

1880. BOWLES, G. J.—*Agrotis jaculifera*. Rep. Ent. Soc. Ont., 1879, p. 41. Compared to *A. subgothica*.

1881. MARTEN, JOHN.—*Agrotis subgothica*. 10th Rep. St. Ent. Ill., p, 132, fig. 44. Description of larva. Larvæ destructive in June. Chrysalids, July. Moths, September.

1885. LINTNER, J. A.—Idem. Cutworms, p. 6, fig. 10. Destructive to INDIAN CORN.

11. Western Striped Cutworm.

(*Agrotis herilis*, Grote.)

1852. Guenee, A.—*Agrotis jaculifera*, var. b. Sp. Gén. Lép. V., Noct. I., 262. Original description.

1856. Fitch, Asa.—*Agrotis subgothica*. Rep. N. Y. Insects II., 314. General description of moth. July to September. Illinois. Common. Severs the young stalks by night at or near the surface of the ground. Natural enemies: Crows and predaceous beetles. Remedies: abundance of seed and collecting the larvæ.

1867. Riley, C. V.—Idem. Prairie Farmer, XIX., 414. Specific characters of larva. Called Western striped cutworm.

1869. Riley, C. V.—Idem. Rep. St. Ent. Mo. I., 81. Specific characters of larva with general description of imago. Moths, August, and September. Common.

Packard, A. S., Jr.—Idem. Guide to the Study of Insects, p. 306, fig. 288. Moths often seen flying over blossoms of the golden-rod in autumn.

1873. Grote, A. R.—*Agrotis herilis*. Bul. Buf. Soc. Nat. Sci. I., 99. Names species and clears up synonymy.

1874. Lintner, J. A.—Idem. 26th Rep. N. Y. St. Cab. N. H. p. 180. Collected in N. Y. August 14, 1872.

1875. Cook, A. J.—*Agrotis subgothica*. Rep. Mich. St. Bd. Agriculture, 1874, p. 111, fig. 2. Injurious to Indian corn in Michigan.

1878. French, G. H.—*Agrotis herilis*. 7th Rep. St. Ent. Ill. pp. 90, 205. Specific characters of imago and larva. Pupates May and June. Moths emerge September. Synonymy explained.

1880. Bowles, G. J.—*Agrotis subgothica*. Rep. Ent. Soc. Ont. 1879, p. 40. General description of imago and larva. Moths, August and September. Common in Canada.

1881. Marten, John.—*Agrotis herilis*. 10th Rep. St. Ent. Ill. p. 133. Description of larva.

1885. Lintner, J. A.—Idem. Cutworms, p. 7. Destructive to Indian corn.

12. W-marked Cutworms.

(*Agrotis clandestina*, Harris.)

1842. Harris, T. W.—*Noctua clandestina*. Rep. Mass. Ins. Original description of imago. Abundant in New England. Moths, June to August. Larvæ pass winter half grown. Prefer young Indian corn plants. Early sown buckwheat, young pumpkin plants, young beans, cabbage plants, and many other field and garden vegetables. Remedies: fall plowing and killing by hand.

1856. FITCH, ASA.—Idem. Rep. N. Y. Insects, II., 315, Plate 3, fig. 6. Very common. Larva severs the young stalks by night at or near the surface of the ground. Natural enemies: crows and predaceous beetles. Remedies: abundance of seed and collecting the larvæ.

1862. HARRIS, T. W.—Idem. Insects Injurious to Vegetation, 3d ed., p. 446. (See under 1842.)

1867. RILEY, C. V.—Idem. Prairie Farmer, XIX., 413. Larva described. Injurious to apple buds, young cabbages, and INDIAN CORN. Moths appear in latter part of June.

1869. PACKARD, A. S., Jr.—Idem. Guide to the Study of Insects, p. 309. Specific characters of larva.

1873. LINTNER, J. A.—Idem. 23d Rep. N. Y. St. Cab. N. H., p. 194. Collected in N. Y. July 1.

1874. LINTNER, J. A.—Idem. 26th Rep. N. Y. St. Cab. N. H., p. 180. Collected July 4, 14, and September 23, 1872.

1875. SNOW, F. H.—Idem. Trans. Kan. Acad. Sci., IV., 43. Not common in Kansas.

1878. FRENCH, G. H.—Idem. 7th Rep. St. Ent. Ill., pp. 95, 213. Specific characters of imago and larva. Most abundant species of this group in Middle and New England States. Climbing habit. Food Plants.

1880. BOWLES, G. J.—Idem. Rep. Ent. Soc. Ont., 1879, p. 44, fig. 6. General description of imago and larva. Food plants: INDIAN CORN, wheat, buckwheat, young pumpkins, beans, cabbages, and many other garden plants. Common in Canada and in northern and western United States.

1881. MARTEN, JOHN.—Idem. 10th Rep. St. Ent. Ill., p. 135. Larva described. Climbing habit.

1884. RILEY, C. V.—Idem. Rep. Com. Agriculture, 1884, p. 293, pl. II, fig. 4. Distinguishing features of larva. Moths, June to August. Larvæ hibernate. Pupæ, May and June. Food plants: INDIAN CORN, buckwheat, pumpkin-vines, beans, cabbage, apple buds, and wild endive.

1885. LINTNER, J. A.—Idem. Cutworms, pp. 6, 8. Destructive to INDIAN CORN, cabbage, and beans.

13. DARK-SIDED CUTWORM.

(*Agrotis messoria*, Harris.)

1842. HARRIS, T. W.—*Agrotis messoria*. Rep. Mass. Insects. Original description.

1862. HARRIS, T. W.—Idem. Insects Injurious to Vegetation, 3d ed., p. 444. (See under 1842.)

1867. RILEY, C. V.—*Agrotis cochranis*. Prairie Farmer, XIX., 413. Described as new species. Injuries to fruit trees in Wisconsin and Illinois.

1868. Grote and Robinson.—*Agrotis repentis.* Trans. Am. Ent. Soc. I., 350, pl. 5, fig. 58, ♂. Described as a new species. Atlantic district.

1873. Lintner, J. A.—*Agrotis cochranii.* 23d Rep. N. Y. St. Cab. N. H., p. 194. Collected in N. Y. September 20th.

1875. Cook, A. J.—Idem. Rep. Mich. St. Bd. Agriculture, 1874, p. 144. Very destructive to fruit trees in eastern and western part of Michigan. Natural history. Remedies: collecting larvæ; entrapping with fresh clover; catching by use of sheet and mallet; preventing their ascent of the trees.

1875. Snow, F. H.—Idem. Trans. Kan. Acad. Sci., IV., 43. Common in Kansas.

Snow, F. H.—*Agrotis messoria.* Trans. Kan. Acad. Sci., IV., 44. Common in Kansas.

1878. French, G. H.—Idem. 7th Rep, St. Ent. Ill., pp. 92, 209. Specific characters of imago and larva. Moths, July and August. Climbing habit of larva. Found among cabbages, potato-hills, and in Indian Corn fields and in flower gardens.

1880. Bowles, G. J.—Idem. Rep. Ent. Soc. Ont., 1879, p. 42, fig. 5. General description of imago and larva. Injuries to fruit trees. Michigan, Illinois, and Canada.

1881. Marten, John.—Idem. 10th Rep. St. Ent. Ill., p. 134. Larva described.

1884. Riley, C. V.—Idem. Rep. Com. Agriculture, 1884, p. 290, pl. II, fig. 6. Single-brooded. Larvæ hibernate. Moth, July and August. Injuries to fruit trees. Wide spread in United States.

1885. Lintner, J. A.—Idem. Cutworms, p. 7. Destructive to Indian corn.

14. Striped or Corn Cutworm.

(*Agrotis tessellata,* Harris.)

1842. Harris, T. W.—*Agrotis tessellata.* Rep. Mass. Insects. Original description.

1856. Fitch, Asa.—The Striped Cutworm. Rep. N. Y. Insects, II., 313. Original description of larva. Common in corn fields, cutting off plants half an inch above ground. Buries itself but slightly.

1862. Harris, T. W.—*Agrotis tessellata.* Insects Injurious to Vegetation, 3d ed. p. 445, fig. 221. (See under 1842.)

1863. Fitch, Asa.—*Agrotis nigricans,* var. *maizi.* Rep. N. Y. Insects, IX., 804. Specific characters of imago and larva. Existing knowledge of cutworms. Habits and natural history. Habits compared with those of yellow-headed cut-

worm. Food plants: INDIAN CORN, grass, flax, weeds, and garden plants. Moth appeared July 6. *Calosoma calidum* predaceous upon it. Fall plowing.

1869. PACKARD, A. S., JR.—*Agrotis tessellata.* Guide to the Study of Insects, p. 306, fig. 237. Brief description.

1875. COOK, A. J.—*Agrotis nigricans.* Rep. Mich. St. Bd. Agriculture, 1874, p. 111. Injurious to INDIAN CORN in Michigan.

1878. FRENCH, G. H.—*Agrotis tessellata.* 7th Rep. St. Ent. Ill., pp. 91, 206. Specific characters of larva and imago. Common in southern Illinois. Natural history and habits.

1880. BOWLES, G. J.—Idem. Rep. Ent. Soc. Ont. 1879, p. 39. General description of larva and imago. Very destructive to INDIAN CORN. Common in Canada and the United States.

1881. MARTEN, JOHN.—Idem. 10th Rep. St. Ent. Ill., p. 133. Description of larva.

1885. LINTNER, J. A.—Idem. Cutworms, p. 7. Destructive to INDIAN CORN.

15. GREASY OR BLACK CUTWORM.

(*Agrotis ypsilon*, Rott.)

1842. HARRIS, T. W.—*Agrotis telifera.* Rep. Mass. Insects. Description of imago.

1852. GUENEE, A.—*Agrotis suffusa* var. *idonea.* Hist. Nat. des Insectes, I., 269. Common in Europe, East Indies, and in greater part of America in June and September.

1862. HARRIS, T. W.—*Agrotis telifera.* Insects Injurious to Vegetation, 3d ed. p. 443. (See under 1842.)

1867. RILEY, C. V.—Idem. Prairie Farmer, XIX., 414. Original description of larva.

1869. RILEY, C. V.—Idem. 1st Rep. St. Ent. Mo., p. 80. Specific characters of larva, chrysalis, and imago. Moths, July. Larva destructive to tomato and INDIAN CORN in Missouri.

PACKARD, A. S., Jr.—*Agrotis suffusa.* Guide to the Study of Insects, p. 306, fig. 239. Description of larva. Chrysalids at roots of INDIAN CORN in Maryland.

1875. SNOW, F. H.—Idem. Trans. Kan. Acad. Sci., IV., 44. Common in Kansas.

1878. FRENCH, G. H.—*Agrotis ypsilon.* 7th Rep. St. Ent. Ill. pp. 93, 210. Specific characters of imago and larva. Abundant throughout United States. Very destructive in INDIAN CORN fields and gardens in Illinois.

1880. BOWLES, G. J.—*Agrotis telifera.* Rep. Ent. Soc. Ont. 1879, p. 40, fig. 3. General description of imago and larva. Food plants. Very common in Canada from June until October. First specimen taken at sugar, October 1.

1881. MARTEN, JOHN.—*Agrotis ypsilon.* 10th Rep. St. Ent. Ill. p. 134, fig. 46. Description of larva. Pupates in June; emerges in July. Food plants: INDIAN CORN, tobacco, tomato plants and cypress vines.

1884. RILEY, C. V.—Idem. Rep. Com. Agriculture 1884, p. 294, pl. II, fig. 2. Original description of egg. General description of imago and larva. Natural history and habits. Probably both one- and two-brooded. Pernicious cutting habit. World-wide.

1885. LINTNER, J. A.—Idem. Cutworms, p. 7. Destructive to INDIAN CORN.

16. VARIEGATED CUTWORM.

(*Agrotis saucia*, Hübn.)

1796. HUBNER, JACOB.—*Agrotis saucia.* Samml. Europ. Schmett, p. 378. (*Teste* Guenée.) Original description.

1823. FREYER, C. F.—Beitr. zur Schmett. (*Teste* Guenée.) Description of larva.

1842. HARRIS, T. W.—*Agrotis inermis.* Rep. Mass. Ins. Description of imago.

1852. GUENEE, A.—*Agrotis saucia.* Sp. Gén. Lép. V.—Noct. I., 271. Europe and America in June and September. Not rare.

1862. HARRIS, T. W.—*Agrotis inermis.* Insects injurious to vegetation. 3d. ed., p. 444. (See under 1842.)

1869. RILEY, C. V.—Idem. 1st Rep. St. Ent. Mo., p. 72. Specific characters of imago, larva, and chrysalis. Damage to grape vines. Eggs on twigs of trees. Mode of walking when young. Two-brooded. Moth hibernates. Voracious feeders.

1878. FRENCH, G. H.—*Agrotis saucia.* 7th Rep. St. Ent. Ill., pp. 94, 211. Specific characters of imago and larva. Natural history and habits. Probably two-brooded. Not so injurious to INDIAN CORN as some other species. Bores into cabbage heads. Widely distributed.

1880. BOWLES, G. J.—*Agrotis inermis.* Rep. Ent. Soc. Ont. 1879, p. 41. General description of imago and larva. Moth taken August 14. Common in Canada and in Northern and Western States.

1881. MARTEN, JOHN.—*Agrotis saucia.* 10th Rep. St. Ent. Ill., p. 134. Description of larva. Complete transformation in thirty-five days.

1884. RILEY, C. V.—Idem. Rep. Com. Agriculture, 1884, p. 297. General description of imago, larva, and egg. Eggs on apple twigs. General feeder. Damage to young grape vines and lettuce. Extracts from breeding notes. Common throughout North America and Europe.

1885. LINTNER, J. A.—Idem. Cutworms, pp. 7, 8, 9. Destructive to INDIAN CORN, cabbage, and Smilax.

17. Glassy Cutworm.

(*Hadena devastator*, Brace.)

1819. Brace, John P.—*Phalæna devastator*. Silliman's Amer. Journ. of Science I., 154. Original description. Prefers beans. Feeds on cabbage and Indian corn. Pupa state four weeks; emerges about July 13. Eggs laid in autumn and hatch in May. Chrysalids exposed to the sun, died; hence plowing in July suggested.

1842. Harris, T. W.—*Agrotis devastator*. Rep. Mass. Ins. Description of imago. Moths common July 10 to August 15. Believes the eggs hatch in autumn.

1856. Fitch, Asa.—Idem. 2d Rep. N. Y. Insects, p. 315. Description of imago.

1862. Harris, T. W.—Idem. Insects Injurious to Vegetation, p. 445. (See under 1842.)

1869. Riley, C. V.—Idem. 1st Rep. St. Ent. Mo., p. 83, fig. 30, larva. Specific characters of larva and chrysalis. Food plants: grass and cabbage.

Packard, A. S., Jr.—Idem. Guide to Study of Insects, p. 306. Mention.

1873. Lintner, J. A.—*Mamestra devastator*. 23d Rep. N. Y. St. Cab. N. H., p. 194. Collected in N. Y. August 15.

1874. Lintner, J. A.—Idem. 26th Rep. N. Y. St. Cab. N. H., p. 180. Collected July 7 to August 14.

1875. Cook, A. J.—*Agrotis devastator*. Rep. Mich. St. Bd. Agriculture, 1874, p. 111. Injurious to Indian corn in Michigan.

1878. French, G. H.—*Hadena devastatrix*. 7th Rep. St. Ent. Ill., pp. 96, 216. Specific characters of imago and larva. Food plants: Indian corn, grass, and cabbage.

1880. Bowles, G. J.—*Agrotis devastator*. Rep. Ent. Soc. Ont. 1879, p. 38, fig. 2. General description of imago and larva. Common in Canada, Northern and Western United States.

1881. Marten, John.—*Hadena devastatrix*. 10th Rep. St. Ent. Ill., p. 137. Description of larva. Found underground near cabbage plants in May.

1884. Riley, C. V.—Idem. Rep. Com. Agriculture, 1884, p. 296, pl. III, figs. 3, 4. Transformations. About half-grown May 1; pupated June 19; emerged July 7.

1885. Lintner, J. A.—Idem. Cutworms, pp. 7, 8. Destructive to Indian corn and cabbage.

18. The Yellow-headed Cutworm.

(*Hadena arctica*, Boisd.)

1859. Fitch, Asa.—*Hadena amputatrix*. 3d Rep. N. Y. Insects, p. 107. Description of imago. Severing stalks of currants, roses, etc. Common night-flying moth.

1863. Fitch, Asa.—Idem. 9th Rep. N. Y. Insects, pp. 811, 816. Very destructive to Indian corn. Habits compared with those of striped cutworm. Severs Indian corn below surface of ground. Pupates in July.

1874. Lintner, J. A.—*Hadena arctica*. 26th Rep, N. Y. St. Cab. N. H., p. 180. Imago collected in N. Y. June 27 to July 28, 1872.

1875. Cook, A. J.—*Hadena amputatrix*. Rep. Mich. St. Bd. Agriculture, 1874, p. 111. Destructive to Indian corn in Michigan.

1878. French, G. H.—*Hadena arctica*. 7th Rep. St. Ent. Ill., pp. 96, 217. Specific characters of larva and imago. Northern United States and Europe.

1880. Bowles, G. J.—Idem. Rep. Ent. Soc. Ont., 1879, p. 39. General characters of larva and imago. Moths appear July and August. Common in Canada and Northern United States.

1881, Marten, John.—Idem. 10th Rep. St. Ent. Ill., p. 137. Description of larva.

1884. Saunders, W.—Idem. Can. Ent. XVI., 205. Very destructive to Indian corn and other crops in Canada.

1885. Lintner, J. A.—Idem. Cutworms, p. 7. Destructive to Indian corn.

19. The Fall Army Worm.

(*Laphygma frugiperda*, Guen.)

1797. Smith and Abbott.—Insects of Georgia, II., p. 96. (*Teste* Guen.)

1852. Guenee, A.—*Laphygma frugiperda*. Sp. Gén. Lép. V.—Noct. I., 159. Description of imago and larva. North and South America in July. Also reported from Tasmania.

1869. Riley, C. V.—The Wheat Cutworm. 1st Rep. St. Ent. Mo., p. 89. Description of larva. Known to attack wheat for many years in Mo. Appeared only on wheat sown on oat stubble. Early plowing suggested.

1870. Riley, C. V.—*Prodenia daggyi*. Amer. Ent. II., 43, 328. P. 43, injurious to Indian corn. P. 328, Missouri and Illinois. Feeds upon wheat, oats, Indian corn, barley, grasses, purslane, and turnips.

RILEY, C. V.—*Prodenia antumnalis*. Amer. Ent. II., 363, fig. 221. Specific characters of imago, larva, and pupa. Kansas. Variable. Larvæ appeared in multitudes August and September. Moths abundant September and October. Several-brooded. Feeds also on apple and peach leaves. Feeds extensively on wheat sown on oat stubble. Tachina parasite.

1872. GLOVER, TOWNEND.—Idem. Rep. Com. Agriculture, 1872, p. 118. Destructive to INDIAN CORN, grass and pea crops, in Georgia and Florida.

1878. FRENCH, G. H.—*Laphygma frugiperda*. 7th Rep. St. Ent. Ill., pp. 97, 219. General character of imago and larva. Very destructive to young INDIAN CORN in central Illinois in 1868. Also, sometimes, to wheat, rye, and grass. Two-to four-brooded.

1881. MARTEN, JOHN.—Idem. 10th Rep. St. Ent. Ill., p. 138, fig. 48. Description of larva. Appears in the fall, and feeds on both wheat and INDIAN CORN.

1884. FORBES, S. A.—Idem. 14th Rep. State Entomologist of Illinois, pp. 55–67. Pl. v, figs. 1 and 2. General article under heads of Literature, Nomenclature, Description, Distribution, Life History, Injuries to Vegetation, Natural Enemies, and Methods of Prevention and Remedy. Describes extensive injuries to wheat in central Illinois, fall of 1884. New species of parasite, *Exorista infesta*, Williston.

20. THE BRONZE-COLORED CUTWORM.

(*Nephelodes violans*, Guen.)

1852. GUENEE, A.—*Nephelodes violans*. Sp. Gén. Lép. V.—Noct. I., 130. Original description. New York and Illinois.

1873. LINTNER, J. A.—Idem. 23d Rep. N. Y. St. Cab. N. H., p. 194. Imagos collected August 27, in N. Y.

1874. LINTNER, J. A.—Idem. 26th Rep. N. Y. St. Cab. N. H., p. 180. Collected September 6, 1872.

1875. SNOW, F. H.—Idem. Trans. Kan. Acad. Sci. IV., 45. Common in Kansas.

NORMAN, GEO.—Idem. Can. Ent. VII., 6. Common in Ontario. Collected September 1.

1876. NORMAN, GEO.—Idem. Can. Ent. VII., 69. Collected August 21. Very frequent.

1878. FRENCH, G. H.—Prairie Farmer, April 6, 1878. Original description of larva.

FRENCH, G. H.—*Nephelodes violans*. 7th Rep. St. Ent. Ill., pp. 99, 220. Specific characters of larva and imago. Habits. Pupated in June, emerged in September. Feeds on INDIAN CORN and grass.

FRENCH, G. H.—Idem. Can. Ent. X., 61. Specific characters of larva. Transformation and food habits. Feeds mostly at night.

1880. Forbes, S. A.—Idem. Amer. Ent. III., 231. Larva from stomach of blackbird.

1880. Riley, C. V.—Idem. Amer. Ent. III., 205. Common in northern Illinois and Missouri in early spring on blue-grass sod. Full-grown larva hibernates. Widely distributed.

1881. Riley, C. V.—Idem. Amer. Nat. XV., 575. Specific characters of larva. Habits and distribution. Pupates in June and emerges in autumn.

Marten, John.—Idem. 10th Rep. St. Ent. Ill., p. 139. Specific characters of larva. Food plants and transformation.

Osborn, Herbert.—Idem. Iowa Homestead, June 17, 1881. (*Teste* Lintner.) Diseased larvæ.

1882. Lintner, J. A.—Idem. 1st Rep. Injurious and other Insects St. N. Y., p. 99. Specific characters of moth and larva. Injuries in St. Lawrence county, New York. Difficulty of rearing larvæ. Dates of collection of larvæ, April 24 to June 29. Literature and bibliography. Natural history. Food plants: grass, clover, and Polygonum. Widely distributed. United States and Canada. Parasites. Preventives and remedies: deep plowing, burning, rolling, and attracting by sweetened substances.

21. The Stalk Borer.

(*Gortyna nitela*, Guen.)

1842. Harris, T. W.—Rep. Mass. Ins. Larva described but not identified. Common in potato stalks.

1852. Guenee, A.—*Gortyna nitela*. Sp. Gén. Lép. V.—Noct. I., 124. Original description. Illinois.

1862. Harris, T. W.—Insects Injurious to Vegetation, 3d ed., p. 440, fig. 219. (See under 1842.)

1867. Walsh, B. D.—*Gortyna nitela*. Prac. Ent. II., 115. Description of pupa. Difference between habits of *Gortyna nitela* and those of *Achatodes zeæ*. Destruction of hibernating moths a check on its undue increase.

Riley, C. V.—Idem. Prairie Farmer, XIX., 116. Specific characters of imago, chrysalis, and larva. Imago and larva figured. Bores into dahlia and astor. Life history. Larvæ July; pupæ August; moths emerge September.

1868. Walsh and Riley.—Idem. Amer. Ent. I., 22, fig. 11; p. 206, fig. 110; p. 258. P. 22, abundant in parts of Missouri and Illinois. Boring through cob of growing Indian corn. Life history and food plants. Pupates in ground, latter part of July. Emerges September and is supposed to hibernate as an imago. P. 206, fig. 140, in peach twigs. P. 258, much damage to Indian corn in Connecticut.

1860. Walsh and Riley.—Idem. Amer. Ent. II., 42, 43. Often bores into stem of Indian corn plant.

RILEY, C. V.—Idem. 1st Rep. St. Ent. Mo. p. 92, figs. 35. 36. Food plants: Potato, tomato, dahlia, astor, cocklebur (*Xanthium strumarium*). Natural history. Single-brooded moths probably hibernate. Prevention, careful inspection of wilting stalks.

HARRIS, T. W.—Entomological Correspondence, p. 135. Specific characters of larva. Found in potato and pigweed stalks.

PACKARD, A. S., Jr.—*Gortyna nitela*. Guide to the Study of Insects, p. 310, fig. 241. Brief description of larva and imago. Habits and life history.

1871. LEBARON, WM.—Idem. 3d Rep. St. Ent. Ill., p. 141. Figured. Destructive to wheat in Wisconsin. Two acres of very early wheat entirely destroyed. Question of possible rate of multiplication important.

1876. RILEY, C. V.—Idem. 8th Rep. St. Ent. Mo. p. 37. Shape and character of ovipositor.

1877. PRAIRIE FARMER, July 21.—Idem. In late planted SWEET CORN. Remedies: lights, Paris green, and close inspection.

PACKARD, A. S., Jr.—Idem. 9th Rep. G. G. Surv. Terr. for 1875, p. 719, pl. 65, fig. 6. (*Teste* Lintner.) Brief notice.

1878. SMITH, EMMA A.—Idem. 7th Rep. St. Ent. Ill. p. 112. Description larva, pupa, and imago. Various complaints of injury to INDIAN CORN. Life history. Does not always leave stalk to pupate. Food plants, nineteen species. Freedom from them in some gardens due probably to presence of fowls. Preyed upon by a parasite.

FRENCH, G. H.—Idem. 7th Rep. St. Ent. Ill., p. 221. Description of larva and moth. Very destructive to INDIAN CORN in localities. Most injurious to INDIAN CORN following oats. Preventive, clean culture.

1879. LINTNER, J. A.—Idem. Country Gent. XLIV., 503. Description of moth and larva. Reported injurious to potatoes. Caterpillar active. Arches its back in walking. Food plants. Life history.

1880. LINTNER, J. A.—Idem. Country Gent. XLV., 472. Reported in potato stalk. Depredations seem to be on the increase.

LINTNER, J. A.—Idem. 39th Rep. N. Y. St. Agric. Soc., 1879, pp. 48, 52, fig. 1, 2. (*Teste* Lintner.)

p. 56. Identifies the species with *G. nebris*. Normally pupates in stalk.

1881. RILEY, C. V.—Idem. Gen. Ind. Mo. Reports, Supplement,

1882. LINTNER, J. A.—Idem. 1st Rep., Injurious and Other Insects, St. N. Y. p. 110. Description moth and larva. A pest to potatoes, INDIAN CORN, wheat, etc., at intervals in certain localities. Larvæ failed to mature. Food plants, twenty species. Recorded depredations. Illinois, Missouri, Wisconsin, Connecticut. Habits and number species of family. Allied species. Natural history. In case of injury to potatoes, stalks may be burned.

1883. FORBES, S. A.—Idem. 12th Rep. St. Ent. Ill., p. 103, fig. 23. Found slightly injurious to oats throughout central and northern Illinois in July and August. One larva doubtless destroys many stalks. Remedy,—clean culture.

22. THE SPINDLE WORM.

(*Achatodes zeæ*, Harr.)

1842. HARRIS, T. W.—*Achatodes zeæ*. Rep. Mass. Insects. Original description; imago, chrysalis, and larva. Destructive to INDIAN CORN, boring into the young stalks. Pupates in stalk. Moth emerged in August. Feeds also in elder and dahlia. Larva should be sought for and killed.

1852. GUENEE, A.—*Achatodes sandix*. Sp. Gén. Lép. V.—Noct. I., 132. Description imago. New York.

1862. HARRIS, T. W.—*Achatodes zeæ*. Insects Injurious to Vegetation, 3d ed., p. 438, pl. VII, fig 9. (See under 1842.)

1867. WALSH, B. D.—Idem. Pract. Ent. II., 115. Habits of larva contrasted with those of *C. nitela*. Attacks younger INDIAN CORN.

1869. PACKARD, A. S., Jr.—Idem. Guide to the Study of Insects, p. 311. Description of imago and larva. Food plants.

1875. SNOW, F. H.—Idem. Trans. Kan. Acad. Sci. IV., 46. Not common as yet in Kansas. Bores into the stalks of INDIAN CORN and is very destructive in the New England States.

1878. FRENCH, G. H.—Idem. 7th Rep. St. Ent. Ill., pp. 100, 222. Specific characters of imago with description of larva. Found throughout northern Illinois.

23. THE ARMY WORM.

(*Heliophila unipuncta*, Haw.)

1810. HAWORTH, A. H.—*Noctua unipuncta*. Lepidoptera Britannica IV., 177. (*Teste* Riley.) The original description of imago from one specimen found in the collection of Mr. Francillon.

1852. GUENEE, A.—*Leucanea extranea*. Sp. Gén. Lép. V.—Noct. I., 77. Description of imago. Very common in North America, Brazil, Columbia, etc.

1861. FITCH, Asa.—*Leucania unipuncta*. 6th Rep. N. Y. Insects, pp. 855, 866. Specific characters of imago. Injuries to INDIAN CORN and grass. Past history and bibliography. Habits and reasons for sudden appearance. Effects of dry and wet seasons. Remedies and preventives: reclaiming swamps, burning grass lands in fall. Parasite,—*Ichneumon leucaniæ*, n. s.

FITCH, ASA.—Idem. The Cultivator IX., 278. Received specimens from Illinois, Iowa, and Maryland. Sketch of recorded history.

FITCH, ASA.—The Army Worm Moth. Illinois Farmer VI., 243. Country Gent. and Cultivator, July, 1861. Description and identification of species.

WALSH, B. D.—*Leucania unipuncta.* Insects Injurious to the Vegetation of Illinois, pp. 17-40. Specific characters of imago and larva. Habits and life history. Breed in timothy and other grass meadows, and migrate to other fields. Almost invariably destroy INDIAN CORN. Food plants: wheat, rye, INDIAN CORN, sorghum, Hungarian grass. Supposes them to be single-brooded, for which opinion he gives several reasons. Recommends burning tame grass meadows annually in the dead of the year. Four parasites known. Irregularity due to this cause. Parasites: *Exorista leucaniæ* (*Senometopia militaris*), *Mesochorus vitreus*, *Microgaster militaris*, *Chalcis albifrons*. Original descriptions of last three.
Also in Trans. Ill. St. Bd. Agr. IV., 349–372; and Prairie Farmer, July, 1861.

THOMAS, CYRUS.—Idem. Prairie Farmer, October, 1861. Controversial article upon the stage in which the insect hibernates. Believes they do not hibernate in egg state, and that they are not double-brooded.

THOMAS, CYRUS.—Further from the Army Worm. Prairie Farmer, 1861. Cited instances of benefit by burning stubble. First appearance in Jackson county, April 29; final disappearance about June 10. Dates of transformation.

WALSH, B. D.—The Army Worm. Prairie Farmer, December, 1861. Reply to Cyrus Thomas on the subject of hibernation, with breeding notes from Dr. Bartlett, Champaign county, Illinois.

THOMAS, CYRUS.—The Army Worm. Prairie Farmer, 1861. Description of larva. Dates of appearance and transformation. Speculations on its life history. Remedies. Arguments in favor of pupal hibernation.

THOMAS, CYRUS.—Idem. Illinois Farmer, 1861, pp. 269-273. Describes larva, pupa, and imago. Extended account of life history. Recommends plowing grass under when worms are small.

1862. FLINT, C. C.—*Leucania unipuncta.* Harris's Insects Injurious to Vegetation, 3d ed., appendix, pp. 627–630. Description of imago, larva, and pupa. Best method of arresting their ravages; that commonly practiced is plowing a double furrow around the field. Worms thus trapped may be destroyed by fire or hogs. Rolling recommended, also hogs, sheep, and fowls.

1865. WALSH, B. D.—The Army Worm. Trans. Ill. St. Agr. Soc. V., 1861–64, pp. 470–483. Figures army worm in its three states, and its primary and secondary parasite: *Senometopia militaris*, *Pezomachus minimus*, *Chalcis albifrons*, *Mesochorus vitreus*,

Microgaster militaris, *Glyphe viridescens*. Arguments in favor of egg hibernation.

GLOVER, TOWNEND.—Army Worm. Rep. Com. Agriculture, 1864, p. 552. Rate of movement. Remedies proposed.

EMERY, H. D.—*Leucania unipuncta*. Prairie Farmer, XVI., 3. Appeared in great numbers in Missouri. Examples of benefit derived from burning meadows.

1867. WALSH, B. D.—Idem. Prac. Ent. II., p. 112. Only one-brooded. Moths usually emerge same year, although some do not transform till following year.

1869. WALSH AND RILEY.—Idem. Amer. Ent. I., 214. Numerous in parts of Illinois and Missouri. Habits and natural history. Single-brooded. Burning, fall plowing, and ditching suggested. Parasites numerous. May sometimes be beneficial by devouring chess or by stripping off blades affected with rust.

PACKARD, A. S., Jr.—Idem. Guide to the Study of Insects, p. 305, pl. VIII, fig. 2. Brief description and habits.

1870. RILEY, C. V.—Idem. 2d Rep. St. Ent. Mo., pp. 37, 56, figs. 14, 15, 16. Specific characters of larva and imago. Compared with *Clisiocampa sylvatica*, Harr; *Anomis xylina*, Say; *Laphygma frugiperda*, Guen. Past history. Appearance and disappearance due to climatic influences and attack of eight parasites. Natural history. Supposed to be mostly single-brooded, and to hibernate mostly in chrysalis state. Parasites described: *Exorista leucaniæ*, Kirk; *Exorista flavicauda*, Riley; *Mesochorus vitreus*, Walsh; *Pezomachus minimus*, Walsh; *Microgaster militaris*, Walsh; *Ophion purgatus*, Say. Also mentions *Chalcis albifrons*, Walsh, *Ichneumon lucaniæ*, Fitch, and two undescribed species. Remedies and preventives suggested.

1871. GLOVER, TOWNEND.—Army worm. Rep. Com. Agr. 1870, p. 83. Brief life history. Generally one-brooded. Northern States.

1875. SNOW, F. H.—*Leucania unipuncta*. Trans. Kan. Acad. Sci. IV., 47. Abundant, especially in wet seasons following very dry ones. Probably the most destructive species among all Lepidoptera, often attacking and destroying entire fields of INDIAN CORN, wheat, oats, grass, and other staple crops.

1876. RILEY, C. V.—Idem. 8th Rep. St. Ent. Mo. pp. 22–56 and 182–185. The term "army worm" applied to various insects. Past history of the army worm. Known in Missouri since 1854. Unusual abundance in vicinity of Peshtigo, Wisconsin, in 1872,—the season following the memorable fires of 1871. History in 1875—very general all over the country. Sexual differences—several organs figured. Natural history of species; occurs in Europe, Asia, New Zealand, and Australia. Original account of oviposition, with description of egg. Hibernates as imago and pupa; perhaps also as larva and egg. Habits of worm. Why it escapes destruction

when young. Why it travels in armies. Appears in April and May. Only one annual brood. Plants preferred. Climatic influences; natural enemies, and remedies. Summary of leading facts.

Cook, A. J.—Idem. Rep. Mich. Bd. Agriculture 1875, pp. 278–282. An account of appearance in southern portion of State, with natural history, dates of capture, disposition of eggs, and effect of parasites.

1877. Riley, C. V.—Idem. 8th Rep. St. Ent. Mo., pp. 47–50. Further notes and experiments. Eggs are thrust in between the sheath and stalk of well-grown grasses whether cut or standing; also in other places. Laid in single row of from five to twenty. Proves them to be double-brooded in latitude of St. Louis. Summary of natural history.

Thomas, Cyrus.—Idem. 6th Rep. St. Ent. Ill., p. 56. Considerable damage done in 1875, especially to young Indian corn. Acts in two rôles: first as a true cutworm; and second as a social and migratory race. Climatic conditions chief cause of disposition to migrate. Larvæ destroyed by chickens, birds, and heat. Best preventive, burning meadows in spring.

1878. French, G. H.—Idem. 7th Rep. St. Ent. Ill., pp. 101, 224. Specific characters of imago. Indian corn subject to attack by migratory broods, and by those acting as cutworms. Preventives: ditching, and burning meadows. Two- or three-brooded. Fresh specimens captured in April.

1879. Lintner, J. A.—Idem. Country Gentlemen XLIV., 422. Reply to inquiry from Maryland. Brief description and natural history. Destruction by parasites. Two-brooded in Southern States; single-brooded in Northern States.

Smith, Emily A.—*Heliophila unipuncta*. Prairie Farmer, Aug. 16, 1879. Paper read before a meeting of the Wisconsin Horticultural Society, at Green Bay. A *resumé* of known habits, natural history, natural enemies and remedies.

1880.—Riley, C. V.—*Leucania unipuncta*. Amer. Ent. III., 170, 134, 214. P. 170, marked irruption in many parts of Maryland, Delaware, and New York. Characters of moth, larva, and pupa. Natural history and remedies. P. 184, appearance in the Atlantic States has added new facts. Number of annual generations. How insect hibernates in larval state. The destructive brood probably not the first of the season. P. 214, burning is a preventive, destroying appropriate nidus for the laying of the eggs by the moth in spring. Connection of wet and dry seasons with rate of increase.

Comstock, J. Henry.—*Heliophila unipuncta*. Rep. Com. Agriculture 1879, p. 187, pl. 1, figs. 1 and 3. Known in this country since 1743, and found in almost every part of the world. Natural history studied since 1861. Description of egg, larva, pupa, and imago. Two- to many-brooded. Arguments in favor of hibernation as egg, larva, pupa

and moth. Probably hibernates in all except the egg state. Swamp land and wet-and-dry-season theory discussed. Best methods of destroying actual depredators are rolling, or poisoning with arsenic, etc. Ditching and pitting recommended. Twelve species of insect enemies enumerated.

SCIENTIFIC AMERICAN, June 26.—The Army Worm. An account of its occurrence in Long Island. INDIAN CORN was eaten off close to the ground. Also a compiled account of habits, life history, descriptions, and remedies.

RURAL NEW YORKER, June 12, 1880.—Idem. Its appearance in Long Island in vast numbers. Wheat, rye, and INDIAN CORN fields destroyed. The entire crops of the Island threatened.

COMSTOCK, J. HENRY.—Idem. Farmers' Review, July 8, 1880. Discusses the theory that the natural habitat of the army worm is in the wild grass of wet spots, in swamps, and on the borders of marshes, and expresses doubts of the correctness of the theory. Remedial agencies: rolling, poisoning with arsenic, and trapping by ditches and pits.

THOMAS, CYRUS.—Idem. 10th Rep. St. Ent. Ill., pp. 5, 44, figs. 1, 2 and 3. Its past history. Natural history, and description of egg, larva, pupa, and moth. Terms of life; dates of capture of the moth; notices of the larva; number of broods; and hibernation. Proper home of the species and character of seasons favorable to its development. Natural enemies: ten parasites described and ten predaceous beetles mentioned. Remedies: ditching, burning meadows, poisons.

1881. THOMAS, CYRUS.—Idem. Can. Ent. XIII., 191. Stated at a meeting of the A. A. A. S. that the army worm existed as a caterpillar, chrysalis, and moth seventy-seven days; from which B. P. Mann and C. V. Riley dissented.

FORBES, S. A.—Idem. Bloomington Pantagraph, July 28, 1881. Account of ravages in McLean and adjacent counties. Natural history, injuries, and remedies.

THOMAS, CYRUS.—Idem. Prairie Farmer, August 6, 1881. Beheading oats in Hancock county. Brief sketch of habits, natural history, descriptions, and remedies. Instances of early variety of oats escaping injury.

THOMAS, CYRUS.—Idem. Rural New Yorker, Jan. 29, 1881. Number of annual generations. Cited proofs of second brood. Proper home of the species and character of the seasons favorable to its development discussed with reference to the views of Riley and Comstock.

COOK, A. J.—*Leucania unipuncta.* Can. Ent. XIII., 215. In 1881, observed, for the first time, injuring INDIAN CORN in Michigan. This was a dry season following a wet one.

SAUNDERS, WM.—Idem. Can. Ent. XIII., 198, 215. Much damage in Canada. Double-brooded; probably hibernate in larval state; destructive brood not being the first one.

1882. Riley, C. V.—Idem. Rep. Com. Agriculture, 1881, pp. 89–106, pl. II and pl. VI, figs. 1–3. Chiefly from 3d Rep. U. S. Ent. Com., p. 89–156.

Coquillet, D. W.—Idem. 11th Rep. St. Ent. Ill., pp. 49–64. Description of larva. Habits and life history. Dates moths emerge. Seasons most favorable to its rapid increase. Migratory habit. Finds two distinct races of army worm. Sedentary race rears three broods in one season, and hibernates in larval state. Migratory worms are the progeny of moths which were bred in some remote locality and migrated to the locality in which the worms appeared. Natural enemies: *Exorista leucaniæ*, Kirk, *Microgaster militaris*, Walsh; doubtless also larvæ of *Galerita janus*, Fab., and occasionally the common striped gopher.

1883. Riley, C. V.—Idem. 3d Rep. U. S. Ent. Com., pp. 89–156. Gives names of insects with which it is sometimes confounded; history of its synonymy; geographical distribution; capacit injury; past history; specific characters of the egg, larva, pupa, and imago; sexual differences; habits and natural history; time and place of laying eggs; mode of oviposition; fertility; duration of egg state; habits when young; duration of larval life; traveling habits; time of appearance; sudden appearance and disappearance. Food plants; duration of the pupa state; habits of the moth; flight; position when at rest. Number of annual generations normally three, and possibly or exceptionally four, for all points between the Ohio River and the Great Lakes and north to central New York. In the latitude of Washington there are at least five annual generations, and possibly a sixth. Hibernation. Natural enemies: some twenty-five species enumerated. Remedies proposed: burning old grass, ditching coal tar, poisoning, rolling, fencing, and roping. Accounts from correspondents. Extended bibliography.

Forbes, S. A.—Idem. 12th Rep. St. Ent. Ill., p. 102, fig. 22. Dates of appearance. Evidence of three distinct broods in central and southern Illinois. Abundance and disappearance due to parasites. Of seventy-six pupæ, but one reached maturity.

24. The Corn Worm.

(*Heliothis armiger*, Hübn.)

1796. Hubner, Jacob.—Eur. Schmett, p. 370 (*Teste* Guenée.) Original description.

1842. Freyer, C. F.—Beitr. zur Schmett, III., pl. 203. First figure of larva.

1844. Duponchel, P. A. J.—Hist. Nat. Lép. France, IV., 316, pl. 119, figs. 5, 6. Description of larva.

1852. GUENEE, A.—*Heliothis armigera*. Gén. Lép. VI.—Noct. II., 181. Southern Europe, North and South America, East Indies, and probably in other parts of the globe, in July and August. Common.

1855. GLOVER, TOWNEND.—Corn Worm. Rep. Com. Patents, 1854, pp. 6–71. [Not seen.]

1856. GLOVER, TOWNEND.—The Boll Worm (*Heliothis ?*). Rep. Com. Patents 1855, pp. 98–103. Pl. IX, fig. 4. Treats it as a fall army worm, and states that it will probably prove identical with corn worm treated in preceding report. Gives description of egg and moth; life history, habits, injuries, and remedies.

1862. GROTE, A. R.—*Heliothis umbrosus*. Proc. Ent. Soc. Phila. I., 219. Description of moth. Stated to be specifically distinct from *H. armigera*.

1865. GLOVER, TOWNEND.—Corn worm. Rep. Com. Agriculture, 1864, p. 554. States that he has bred worms from both INDIAN CORN and cotton-balls, and the moths produced were identical.

1866. GLOVER, TOWNEND.—*Heliothis amigera*. Rep. Com. Agriculture 1865, p. 43. An instance reported from South Carolina where crows that were supposed to be injuring corn proved to be feeding upon this worm.

1869. WALSH AND RILEY.—Idem. Amer. Ent. I., 212, 214, figs. 150, 151. Very destructive to INDIAN CORN in southern Illinois, sometimes destroying whole fields. First eats off the silk, and then, sheltered by the husk, feeds upon the soft kernels. Is two-brooded and consequently most destructive to very late corn. Life history, habits, and description of the insect in its various stages. Hand-picking suggested.

WALSH AND RILEY.—Idem. Amer. Ent. II., 42–44, fig. 29. Quote Mrs. Treat's statement that the larvæ feeding upon tassels of INDIAN CORN and upon green peas differ in color from those feeding upon soft ears of corn, and state that this is not without parallel among two-brooded insects. Mention injuries in southern Illinois, Kentucky, and Kansas. Suggest topping corn to destroy first brood.

TREAT, MARY.—Idem. Vineland [N. J.] Weekly, Aug. 21, 1869. Feeds upon the undeveloped tassels of INDIAN CORN.

1870. RILEY, C. V.—Idem. Amer. Ent. II., 329. Often found in company with fall army worm (*Laphygma frugiperda*, Guen.) on ears of late INDIAN CORN. Characters which distinguish it from fall army worm.

1871. RILEY, C. V.—Idem. 3d Rep. St. Ent. Mo. pp. 104–109, figs. 42, 43. States that former belief that corn worms were unable to feed on fully ripened corn is incorrect. Other points chiefly compiled from Amer. Ent. I., 212 and II., 42.

GLOVER, TOWNEND.—Idem. Rep. Com. Agriculture, 1870, p. 84. Very injurious not only to cotton and INDIAN CORN, but to green peas, pumpkins, and tomatoes.

1872. RILEY, C. V.—Idem. 4th Rep. St. Ent. Mo., p. 129. *Tachina anonyma* bred from this species and from several others.

GLOVER, TOWNEND.—Idem. Rep. Com. Agriculture, 1871, p. 84. Reported injurious from Florida, Georgia, Louisiana, and Arkansas.

1878. LINTNER, J. A.—Idem. Entomological Contributions, IV., 52, 53. Occurence and habits in Patagonia.

FRENCH, G. H.—Idem. 7th Rep. St. Ent. Ill. pp. 102–106, 231–233. Damaged ears of growing INDIAN CORN in southern Illinois. The author confirms Prof. Riley's statements of injury. Proposes early planting, topping corn, and fall plowing as remedies. Gives specific characters of larva, chrysalis, and moth.

1879. COMSTOCK, J. HENRY.—Idem. Rep. on Cotton Insects, pp. 287–315. The most complete article that has been written on this insect, giving extent of injuries; nomenclature; georaphical distribution; food plants; description of egg, larva, chrysalis, and moth; number of broods; influence of weather; parasites, and artificial remedies.

1880. CLAYPOLE, E. W.—Idem. Amer. Ent. III., 278. An account of this worm's feeding upon ripened kernels of INDIAN CORN in Ohio.

1881. COQUILLET, D. W.—Idem. 10th Rep. St. Ent. Ill., p. 150. Figures and larval description. Feeds on INDIAN CORN, living within the husks August to November.

1882. MOFFAT, J. ALLSTON.—Idem. Rep. Ent. Soc. Ont., 1881, p. 30. Occurrence in Ontario. Habits and distribution.

JOHNSON, LAWRENCE.—Idem. Rep. Com. Agriculture, 1881, pp. 150–152. 97 per cent. INDIAN CORN affected in roasting-ear stage in Mississippi. Solitary habits; dates of occurrence; identity with boll worm; artificial remedies and natural enemies.

LINTNER, J. A.—Idem. 1st Rep. Ins. N. Y., pp. 116, 126, figs. 27, 28. First appearance as an injurious insect in New York. Description of caterpillar and moth. Carnivorous. Habits of caterpillar. Food plants. Distribution. Operation as a corn worm; method of attacking corn. Occurrence in New York. Remedies. Benefits from destroying first brood.

FRENCH, G. H.—Idem. 11th Rep. St. Ent. Ill., pp. 82–104. Treated as a boll worm, as a corn worm, and as a tomato worm. Minute descriptions of egg, larva, chrysalis, and moth. Parasites. Climatic influence. Remedies: early planting, topping INDIAN CORN, tall varieties of corn, fall planting, poisoning, hand-picking, rotation of crops, and destroying the moth.

RILEY, C. V.—Idem. Rep. Com. Agriculture, 1881, pp. 145–149, pl. I, and pl. XII, fig. 1. States this insect to be one of the most wide-spread and injurious of the farmers' pests, doing extensive injury to INDIAN CORN in the more northern States in 1881. Treats it with reference to its food plants other than cotton.

Family PYRALIDÆ.

25. MEAL SNOUT MOTH.

(*Asopia farinalis*, Linn.)

1767. LINNE, CARL VON.—*Pyralis farinalis*. Systema Naturæ, Tome I, Part II, ed. 12, p. 881. Original description.

1791. BRAHM, N. J.—Insekten-kalendar fur Sammler & Œkonomen Mainz, p. 521 (*Teste* Guenée.) Mention of larva.

1842. HARRIS, T. W.—*Pyralis farinalis*. Rep. Mass. Ins. Briefly describes moth. States that the larvæ are found in old flour barrels.

1852. GUENEE, A.—Idem. Sp. Gén. Lép. VIII.—Deltoides et Pyralites, p. 119. Description of moth. Bibliography. Very common in Europe in June, July, and August. Also inhabits North America and other countries.

1862. HARRIS, T. W.—Idem. Insects Injurious to Vegetation, 3d ed., p. 475, pl. VII, fig. 8. (See under 1842.)

1869. PACKARD, A. S., Jr.—Idem. Guide to Study of Insects, p. 328. Brief description and food plants.

1873. LINTNER, J. A.—Idem. 23d Rep. N. Y. St. Cab. N. H., p. 197. Moth collected July 12.

1874. LINTNER, J. A.—*Asopia farinalis*. 26th Rep. N. Y. St. Cab. N. H., p. 184. Moths collected July 7 and 28.

1875. SNOW, F. H.—*Pyralis farinalis*. Trans. Kan. Acad. Sci. IV., 56. Common in Kansas. Found in old flour boxes and in barns.

1878. FRENCH, G. H.—Idem.—7th Rep. St. Ent. Ill., p. 247. Briefly describes moth and larva. Feeds on INDIAN CORN, straw, and clover.

26. THE SMALLER CORN STALK BORER.

(*Pempelia lignosella*, Zeller.)

1848. ZELLER, P. C.—*Pempelia lignosella*. Isis, 1848, p. 883. Original description.

1882. RILEY, C. V.—Idem. Rep. Com. Agr. 1881, p. 142. Pl. VII, fig. 3. A new INDIAN CORN pest, very destructive in North and South Carolina and Georgia. Habits. Natural History. Preventives. Description of moth: original description of larva and pupa.

27. The Root Web Worm.

(*Crambus zeëllus*, Fernald.)

1885. Fernald, C. H.—*Crambus zeëllus*. Can. Ent. XVII., 55. Original description. Habitat: Maine, Pennsylvania, West Virginia, Illinois, Missouri. Bred from Indian corn by Prof. S. A. Forbes.

Forbes, S. A.—The Root Web Worm. Illinois Crop Rep., May, 1885, p. 38. This is a new insect pest seriously injuring young corn in May and June. Larva and moth described. Manner of affecting plant. Dates and places of taking worms. Larva figured.

Forbes, S. A.—Further notes on the Root Web Worm. Statistical Rep. Ill. St. Bd. Agriculture, June, 1885, p. 48, figs. 1, 2, 3. Injurious to corn in Champaign county. Expresses doubt as to eggs being laid in spring. Describes nest and character of injury, recommends collecting by hand and advises leaving old hills of Indian corn undisturbed when replanting.

Farmers' Review, June 11, 1885.—The Corn Root Worm. Extract from article by Prof. Forbes in Ill. Crop Rep. for May, 1885.

Prairie Farmer, July 11, 1885.—*Crambus zeëllus*. Figure of imago, larva, silken tube, and affected Indian corn. Natural history and remedies. Compiled from article by Prof. Forbes in Ill. Crop. Rep., May, 1885.

Forbes, S. A.—*Crambus zeëllus*. 14th Rep. St. Ent. Ill., p. 12, pl. 1, figs. 1–3. Reported injuries. Original description of larva and pupa. Description of imago. Distribution; life history; natural enemies; and artificial remedies.

29. The Corn Stalk Borer.

(*Diatræa saccharalis*, Fab.)

1793. Fabricius, J. C.—*Phalæna saccharalis*. Ent. Syst. III., ii, p. 238. Original description.

1881. Comstock, J. Henry.—*Diatræa saccharalis*. Rep. Com. Agr. 1880, pp. 240, 243. P. 240, treated as a sugar cane insect. Gives history, habits, life history, amount of damage, and remedies. P. 243, first published account of its injuries to Indian corn. Description of egg, larva, pupa, and moth. Three or more generations; hibernates as larva; injuries five to twenty-five per cent. Remedy, feeding and burning stalks before February. Identity of the insect is not positive.

Family Tortricidæ.

29. The Red-banded Leaf Roller.

(*Lophoderus triferanua*, Walk.)

1863. Walker, Francis.—*Cacœcia triferanus*. Cat. Lep. Het. XXVIII., 814. Original description.

1865. Clemens, B.—*Tortrix incertana* ♀. Proc. Ent. Soc. Phila. V., 138. Description of imago.

1868–69. Robinson, C. T.—Idem. Trans. Am. Ent. Soc. II., 278, pl. VI, fig. 57 ♂, 58 ♀. Description of imago. Habitat. Massachusetts, New York, Pennsylvania, Ohio.

1870. Packard, A. S., Jr.—Idem. Mass. Agr. Rep., p. 240. Injurious to cranberry.

1876. Packard, A. S., Jr.—Idem. Hayden's Surv. X., 523. Larva called cranberry worm. Description of imago and pupa.

1879. Walsingham, Lord.—*Lophoderus triferanus*. Illustr. Lep. Het. in Brit. Mus., Part IV., 15, Pl. LXII, fig. 9. Description of imago; synonymy; habitat.

1880. Murtfeldt, Mary E.—*Tortrix incertana*. Amer. Ent. III, 14. Mentioned as a rose insect.

Lintner, J. A.—Idem. The Insects of the Clover Plants, p. 5. Mentioned as a clover insect.

1882–83. Fernald, C. H.—*Lophoderus triferanua*. Trans. Am. Ent. Soc. X., 15. Synonymical catalogue.

1885. Forbes, S. A.—Idem. 14th Rep. St. Ent. Ill., p. 20. Bred from pale green leaf rollers in Indian corn. Heretofore known to be seriously injurious only to the cranberry. History; habits; description of imago; distribution; food plants. Collected May 29; emerged June 30.

30. The Sulphur Leaf Roller.

(*Dichelia sulphureana*, Clemens.)

1861. Clemens, B.—*Crœcia ? sulphureana*. Proc. Phila. Acad. Sci., 1860, p. 253. Original description.

1868–69. Robinson, C. T.—*Tortrix sulphureana*. Trans. Am. Ent. Soc. II., 273. Description; synonymy; and habitat.

1881. Comstock, J. Henry.—Idem. Rep. Com. Agriculture, 1880, p. 255. Injuries to clover. Original description of larva and pupa. Distribution; food plants; natural enemies.

1882. Packard, A. S., Jr.—*Dichelia sulphureana*. Papilio II., 182. Larva redescribed. Occurrence in Maine. Food plants; dates of transformations.

Fernald, C. H.—Idem. Trans. Am. Ent. Soc., X., 21. Synonymical list. Habitat; food plants.

1885. FORBES, S. A.—Idem. 14th Rep. St. Ent. Ill., p. 17, pl. I, fig. 4. Affects to some extent the INDIAN CORN crop. Description of imago, larva, and pupa. Life history; injuries to vegetation; natural enemies; literature.

Family TINEIDÆ.

ANGOUMIS GRAIN MOTH.

(*Sitotroga cerealella*, Oliv.)

1789. OLIVIER, A. G.—*Alucita cerealella*. Encyc. Method. Hist. Nat. Ins. IV., 121. Original description.

1846. OWEN, RICHARD.—Remarks on the Grain Moth. Flying Weevil. The Cultivator, New Series, III, 208, 344. P. 208, specific characters of egg, larva, pupa, and moth. Food plants; distribution; life history; nature of injury done. Remedies: scalding; kiln drying; salt; sprinkling with lime; friction. Parasite. P, 344, Flying Weevil. Additional notes. Fanning the grain.

1847. FITCH, ASA.—*Anacampsis ? cerealella*. The Cultivator N. S. IV., 13. Generic discussion. Specific marks pertaining to the moth.

1852. HARRIS, T. W.—*Anacampsis* (*Butalis*) *cerealella*. Ins. Inj. Veg. 2d ed., p. 392. Gives synonymy; injuries in Europe and America; description of imago; life history; habits. Two principal broods in a year. Moths raised from INDIAN CORN contrasted with those from wheat. Remedies: heating, fumigating, fanning.

1860. CLEMENS, B.—*Gelechia cerealella*. Proc. Phila. Acad. Nat. Sci., p. 162. Description of imago. Believes it to be introduced from Europe. Received samples in seed wheat from Patent Office at Washington.

1861. FITCH, ASA.—*Butalis cerealella*. 6th Rep. N. Y. Insects, pl. I, fig. 2.

1862. FITCH, ASA.—Idem. 7th Rep. N. Y. Insects, p. 813. In the bins of granaries and store-houses in particular kernels of the grain, a smooth, white worm which consumes all the flour, coming abroad in May and again in November. A tawny, dull yellowish gray moth, having its fore wings commonly sprinkled with a few black dots, its width half an inch across its spread wings. Introduction from Europe. Habits; two-brooded. Description of larva and moth. Parasite mentioned. Remedial agencies.

HARRIS, T. W.—*Anacampsis* (*Butalis*) *cerealella*. Ins. Inj. Veg. 3d ed., pp. 499-510. (See under 1852.)

1865. GLOVER, TOWNEND.—Angoumis Grain Moth. Rep. Com. Agr. 1864, p. 536. Injuries and remedies. Says a moderate application of heat for a considerable time is more efficacious in destroying this insect than intense heat for a short time.

1863. PACKARD, A. S., Jr.—*Gelechia cerealella.* Guide to the Study of Insects, p. 350, figs. 265, 266, imago and larva. Remarkable habit of the larva.

1872. BETHUNE, C. J. S.—*Butalis cerealella.* Rep. Ent. Soc. Ont., 1871, p. 61. Brief account of injuries and remedies.

1878. CHAMBERS, V. T.—*Gelechia cerealella.* (Index to Tineina, U. S. Geol. Surv. IV., 142.) Synonymy and bibliography.

FRENCH, G. H.—Idem. 7th Rep. St. Ent. Ill., p. 266. One of the most destructive insects known to wheat, barley, oats, and INDIAN CORN. Brief description of larva and moth. Remedies.

1882. SAUNDERS, WM.—*Butalis cerealella.* Rep. Ent. Soc. Ont., 1881, p. 5. President's Annual Address. Injuries. Southwestern States. Brief description.

1883. WEBSTER, F. M.—*Gelechia cerealella.* 12th Rep. St. Ent. Ill., p. 144. Extent of injuries. History. Description of moth, larva, and pupa. Habits; life history. Natural checks. Hymenopterous parasite (*Pteromalus gelechiæ* n. s.) described. Heating as remedy. Mite parasite described (*Heteropus ventricosus*, Newp.) with notes on life history.

1884. RILEY, C. V.—Idem. Rep. Com. Agriculture, 1884, p. 345, pl. VI, figs. 2, 3. Past history and distribution. Natural history. Method and results of its work. Two annual generations in more northern States; perhaps five in Southern States. Parasites. Preventives: cribbing CORN with husks on, and storing it shelled. Description of egg.

1885. LINTNER, J. A.—*Sitotroga cerealella.* 2d Rep. N. Y. St. Ent. pp. 102–110. Bibliography. Injuries; history. Description of moth. Food plants; life history; distribution; remedies; natural enemies.

32. THE GRAIN MOTH.

(*Tinea granella*, Linn.)

1847. FITCH, ASA.—*Tinea granella.* The Cultivator N. S. IV., 13. Description of moth and larva. Two-brooded; life history; remedies. Difference in habits of American and European species. Feeds on outside of kernels of INDIAN CORN which it attaches by means of a web.

1860. CLEMENS, B.—*Tinea variatella.* Proc. Phila. Acad. Nat. Sci. 1859, pp. 257, 259. Description of imago. On wing in September.

1862. HARRIS, T. W.—*Tinea granella.* Ins. Inj. Veg. 3d ed., pp. 496–499, pl. VII, figs. 6 and 7. Description of moth and larva. Habits. States that he has seen oats and shelled INDIAN CORN injured by this insect.

1865. GLOVER, TOWNEND.—Grain moth. Rep. Com. Agriculture, 1864, p. 556. Habits and remedies. Salt recommended.

1869. PACKARD, A. S., Jr.—*Tinea granella.* Guide to the Study of Insects, p. 347, fig. 264. Habits, preventives, and remedies.

1875. CHAMBERS, V. T.—Idem. Can. Ent. VII., 125. Remarks on synonymy.

1878. CHAMBERS, V. T.—*Tinea variatella* and *Tinea granella.* (Index to Tineina, U. S. Geol. Surv. IV., 164.) Synonymy and bibliography.

FRENCH, G. H.—*Tinea granella.* 7th Rep. St. Ent. Ill., p. 265. Feeds on stored grain. Brief description of imago. Remedies.

1880. RILLIET, CHARLES.—Idem. Rural New Yorker, May 1, 1880. Reports it in wheat in northern Illinois.

33. THE INDIAN MEAL MOTH.

(*Ephestia zeæ*, Fitch.)

1856. FITCH, ASA.—*Tinea zeæ.* 2d Rep. N. Y. Insects, p. 320 pl. IV, fig. 1. Original description: larva, pupa, imago. Habits. "In stale INDIAN MEAL and emptying cake made thereof; a soft white worm half an inch long, with a brownish yellow head and polished yellowish white spot above on the neck and on the last segment."

1880. RILEY, C. V.—*Ephestia zeæ.* Amer. Ent. III., 229. Reported from Massachusetts. Habits; description of larva.

ORDER DIPTERA.

Family MYCETOPHILIDÆ.

34. THE BLACK-HEADED GRASS MAGGOT.

(*Sciara*, sp. ?)

1884. FORBES, S. A.—The Black-headed Grass Maggot (Sciara sp. ?). 13th Rep. St. Ent. Ill., pp. 57–59, pl. IV, figs. 5–9. Injuries to sprouting INDIAN CORN. Specimens received from various parts of northern Illinois. Classification, and description of imago.

Family ANTHOMYIDÆ.

35. THE SEED-CORN MAGGOT.

(*Anthomyia zeæ*, Riley.)

1869. RILEY, C. V.—*Anthomyia zeæ.* 1st Rep. St. Ent. Mo., pp. 154–156, figs. 86, 87. Original description. Reported from New Jersey as injurious to sprouting INDIAN CORN. Suggests soaking seed corn in gas-tar or copperas.

WALSH & RILEY.—Idem. Amer. Ent. I., 224, figs. 158, 159. Injuring seed corn planted on new ground in Missouri.

1873. THOMAS, CYRUS.—Idem. Prairie Farmer, July 28, 1878. Reported injuring INDIAN CORN in Boone county, Illinois.

1881. RILEY, C. V.—Idem. Gen. Ind. and Supp. Rep. Ins. Mo., p. 89. Description of imago.

1882. LINTNER, J. A.—Idem. 1st Rep. Ins. N. Y., pp. 199-201, figs. 55, 56. Description of larva and imago. Preventives.

Family GEOMYZIDÆ.

36. THE CORN LEAF MINER.

(*Diastata?*)

1881. COMSTOCK, J. HENRY.—Diastata? n. sp. Rep. Com. Agr. 1880, pp. 245, 246. Mining the leaves of garden CORN, making a linear mine five or six inches in length, a small, footless, greenish white maggot, which transforms under ground and eventually becomes a small, active black fly. Original description by L. O. Howard.

ORDER COLEOPTERA.

Family CARABIDÆ.

37. OMOPHRON LABIATUM, Fab.

1801. FABRICIUS, J. C.—*Scolytus labiatus.* Syst. Eleut. I., 248. Original description.

1823. SAY, THOMAS.—*Omophron labiatum.* Trans. Am. Phil. Soc., New Series, II., 80. Complete writings, p. 495. Description of imago.

1869. GLOVER, TOWNEND.—Idem. Rep. Com. Agr. 1863, p. 79. Mentioned as very destructive to young INDIAN CORN in Southern States.

1884. LEBARON, WM.—Idem. 5th Rep. St. Ent. Ill., p. 42. Common at the South. Larvæ feed upon grains of growing INDIAN CORN.

Family COCCINELLIDÆ.

38. THE COMMON LADY BUG.

(*Megilla maculata*, De G.)

1775. DE GEER, CARL.—*Megilla maculata.* Mém. Ins. V., 392, 1, t. 16, fig. 22. (*Teste* Crotch.) Orignal description.

1873. CROTCH, G. R.—Idem. Trans. Am. Ent. Soc. IV., 364. (Revision of the Coccinellidæ of the U. S.) Description of imago. Habitat, U. S., Central and South America.

1880. FORBES, S. A.—Idem. Bul. Ill. St. Lab. Nat. Hist. No. 3, 159. Specimens examined found to contain chiefly pollen grains and fungus spores.

1881. RILEY, C. V.—Idem. Amer. Nat. XV., 326. Reported from Maryland as injurious to INDIAN CORN, eating holes in the blades.

1883. RILEY, C. V.—Idem. Amer. Nat. XVII., 323. Food habits—larva and imago eating soft kernels of INDIAN CORN.

LINTNER, J. A.—Idem. Country Gent. XLVIII., 941. Reported from Connecticut as injuring INDIAN CORN in the ear. Nature of injury described.

1885. FORBES, S. A.—Idem. 14th Rep. St. Ent. Ill., p. 21. Found eating the exposed kernels of INDIAN CORN at the tips of ears.

Family CUCUJIDÆ.

39. SILVANUS SURINAMENSIS, Linn.

1767. LINNÉ, CARL VON.—*Dermestes surinamensis.* Systema Naturæ, II., 565. Original description. Habitat. Surinam.

1885. LE CONTE, J. L.—*Silvanus surinamensis.* Proc. Acad. Nat. Sci. 1854, p. 77. (Synopsis of the Cucuiides of the U. S.) Synonymy and bibliography. Diffused over the whole globe in articles of commerce.

1869. PACKARD, A, S., Jr.—Idem. Guide to the Study of Insects, p. 446. Brief description of imago and larva. Breeds in bran, rice, and wheat.

GLOVER, TOWNEND.—Idem. Rep. Com. Agr., 1868, p. 84, fig. 39. Found in wheat and INDIAN CORN.

1871. GLOVER, TOWNEND.—Idem. Rep. Com. Agr., 1870, p. 66. Food plants: wheat, oats, INDIAN CORN, rye, etc.

1882. LINTNER, J. A.—Idem. 1st Rep. N. Y. Ins., p. 40. Pyrethrum as a remedy.

40. SILVANUS CASSIÆ, Reich.

1855. LE CONTE, J. L.—*Silvanus quadricollis.* Proc. Acad. Nat. Sci. Phila., 1854, p. 78. (Synopsis of the Cucuiides of the United States.) Description of imago. Habitat, Georgia.

1869. GLOVER, TOWNEND.—Idem. Rep. Com. Agr., 1868, p. 84, fig. 41. The egg is deposited in INDIAN CORN near the ground. The larvæ feed upon the substance of the grain.

41. SILVANUS ADVENA, Waltl.

1836. WALTL, JOSEPH.—*Cryptophagus advena.* Silberm. Rev. Ent. II., 256 (*Teste* Le Conte.) Original description.

1854. LE CONTE, J. L.—*Silvanus advena.* Proc. Acad. Nat. Soc. Phila., 1854, p. 78. (Synopsis of the Cucuiides of the United States.) Description of imago. Abundant throughout U. S. in articles of commerce.

1882. RILEY, C. V.—Idem. Rep. Com. Agr., 1881, p. 65. Reported from Washington Co., Mo., as eating grains of INDIAN CORN in the stack.

Family MYCETOPHAGIDÆ.

42. TYPHŒA FUMATA, Linn.

1767. LINNE, CARL VON.—*Dermestes fumatus.* Syst. Nat. Tome I., Pars. II., 564. Original description.

1857. LE CONTE, J. L.—*Typhœa fumata.* Proc. Acad. Nat. Sci. Phila., 1856, p. 15. Description of imago; synonymy; and bibliography.

1882. RILEY, C. V.—Idem. Rep. Com. Agr., 1881, p. 65. Reported from Missouri as working upon INDIAN CORN in stack, eating the grain.

Family NITIDULIDÆ.

43. IPS FASCIATUS, Oliv.

1789. OLIVIER, A. G.—*Nitidula fasciata.* Ent. II., 12, p. 7, pl. 2, fig. 13. Original description.

1835. SAY, THOMAS.—*Ips 4-signata.* Boston Journ. Nat. Hist. I., 169. Complete writings, p. 644. Description of imago.

1861. WALSH, B. D.—Idem. Insects Injurious to Vegetation in Illinois, p. 14. Specimens from St. Paul, Minnesota, reported to have destroyed a great deal of SWEET CORN in that vicinity.

1867. WALSH, B. D.—Idem. Pract. Ent. II., 56. (See under 1861.)

1879. HORN, GEO. H.—*Ips fasciatus.* Trans. Am. Ent. Soc. VII., 323. Description of imago. Habitat; everywhere in the eastern United States, extending to Oregon and Vancouver.

Family TROGOSITIDÆ.

44. TENEBRIOIDES DUBIA, Melsh.

1844. MELSHEIMER, F. E.—*Trogosita dubia.* (Description of New Species of Coleoptera of the United States.) Proc. Acad. Nat. Sci. Phila., 1844, p. 110. Original description. Habitat, Pennsylvania.

1863. HORN, GEO. H.—Idem. Proc. Acad. Nat. Sci. Phila., 1862, p. 85. (Monograph of the species of Trogosita inhabiting the United States.) Description of imago. Habitat, Pennsylvania; common.

1869. GLOVER, TOWNEND.—Idem. Rep. Com. Agr. 1868, p. 83. Destroys wheat, INDIAN CORN and other grains in Maryland.

1871. GLOVER, TOWNEND—Idem. Rep. Com. Agr., 1870, p. 66. (See under 1869.)

Family ELATERIDÆ.

WIREWORMS.

1842. HARRIS, T. W.—Spring Beetles. Rep. Mass. Ins. Characters of family; food plants; future injuries; remedies used in England. Description of six species.

1845. DRUMMOND, ZA.—Wireworms. The Cultivator, New Series, II., 122. (See under Cutworms, 1845.)

1859. THE CULTIVATOR, 3d series, VII., 107.—The Wireworm. Most injurious on moist, loamy soils of a mucky nature. Remedies: fall plowing; plowing grass land just before planting corn; sowing buckwheat.

1861. F.—Wireworms. The Cultivator, 3d series, IX., 284. Failure of remedies. Regular and frequent rotation of crops a preventive.

1862. PERCY, A. G.—Idem. The Cultivator, 3d series, X., 192. (From Rural New Yorker.) Reason given for buckwheat's seeming a remedy.

HARRIS, T. W.—Spring Beetles. Ins. Inj. to Veg., 3d ed., pp. 51–57. (See under 1842.)

1864. GLOVER, TOWNEND.—Wireworms. Rep. Com. Agr, 1863, p. 566. Remedies: alkaline substances, potatoes, turnips, rape cake, etc. Natural enemies: moles, crows, etc.

L. [LINTNER?]—Once more the Wireworm. Country Gent. XXIV., 57. Proper rotation of crops. Crops which are not attacked by wireworms. Rolling, draining.

1865. CHARNOCK, John H.—Wireworms. Country Gent. XXV., 105. Rape cake as a remedy. Its introduction and quantity per acre.

1866. WALSH, B. D.—Idem. Pract. Ent. I., 100. Effect of salt on INDIAN CORN. Thorough culture a remedy for wireworms.

1867. WALSH, B. D.—Idem. Pract. Ent. II., 61, 62. Compared to myriapod.

FITCH, ASA.—Idem. 11th Rep. N. Y. Ins., pp. 519–543. Extensive depredators. Many kinds. Differences in structure of the last segment of the body. Probably two years in attaining maturity. Worm described. Food plants. Low lands preferred. Grass lands their residence. INDIAN CORN crop oftenest destroyed by them. Habits. Remedies: trapping by potatoes, etc; hand picking; growing a crop that will repel them, as white mustard; fall plowing; draining;

rape cake; manure; guano. Natural enemies: crows and rooks. Description of two species.

1868. F.—The Wireworm. Country Gent. XXXII., 121, 122. Regular rotation of crops.

1869. Packard, A. S., Jr.—Elateridæ. Guide to the Study of Insects, pp. 459–462, Character, and habits of family with a brief mention of several species.

1874. LeBaron, Wm.—Idem. 5th Rep. St. Ent. Ill. pp. 96–100. Generic synopsis of family.

1875. Cook, A. J.—Wireworm. Rep. Mich. St. Bd. Agr. 1874, p. 113. Reported quite destructive to Indian corn and potatoes in Michigan. Natural history and remedies.

1876. Thomas, Cyrus.—Elateridæ. 6th Rep, St. Ent. Ill., pp. 115–120. Characters of the family. Description of eight species. Natural enemies. Remedial agencies.

Jones, S. D.—The Wireworm. Prairie Farmer, March, 1876. Remedies: copperas, kerosene. Effect of fall plowing.

Thomas, Cyrus.—Wireworms. 6th Rep. St. Ent. Ill., pp. 21–32. Injuries; characters of the family; general life history; period of a generation, two or three years. Food plants; character of injury. Remedies: hand-picking; salt; lime; soot; hard rolling; guano; hog manure; rotating crops with vegetables that are obnoxious to the worms; burning grass; starving out; coating seed corn in coal tar, or soaking in sulphate of copper solution.

1877. Fernald, C. H.—Idem. Agric. of Maine, 1877, pp. 65–69. Preferred situations; food plants. Under-draining. Description of *Agriotes mancus*.

1878. Thomas, Cyrus.—Idem. 7th Rep. St. Ent. Ill., pp. 19–32. Injuries and remedies, with a description of seventeen species.

1880. Harrington, W. Hague.—On the Elateridæ. Rep. Ent. Soc. Ont., pp. 77–84. Characters of the family; classified as to habits. Food plants. Conflicting opinion in regard to injury to potatoes. Two years probable period of a generation. Remedial agencies; natural enemies. Classification and description of several species.

Dwinelle, C. H.—Wireworms. Pacific Rural Press, March 13, 1880. Reported injuries to wheat in California.

45. Agriotes mancus, Say.

1823. Say, Thomas.—*Elater mancus*. Jour. Acad. Nat. Sci., Phila., III., 171. Complete writings, p. 111. Original description.

1852. Harris, T. W.—*Elater (Agriotes) obesus*. Treatise N. E. In-Insects, 2d ed. Brief description.

1853. Le Conte, J. L.—*Dolopius mancus*. Trans. Am. Philos. Soc., New Series, X., 455. Description, bibliography, and synonymy. Distribution.

1862. HARRIS, T. W.—*Elater (Agriotes) obesus.* Treat. N. E. Insects, 3d ed., p. 56. (See under 1852.)

1866. FITCH, ASA.—*Agriotes truncatus.* 11th Rep. N. Y. Insects, p. 527, figs. 11 and 12—12 larva. Description of larva and imago.

1872. PETTIT, J.—*Agriotes mancus.* Can. Ent. IV., 3. Larvæ feed upon wheat. Bred to adult. An exhaustive description of larva and pupa by Dr. Horn.

1886. FORBES, S. A.—Idem. Bred from wireworms in INDIAN CORN.

46. MELANOTUS COMMUNIS, Gyll.

1817. GYLLENHAL, L.—*Elater communis.* Schönh. Syn. Ins. III., 138. (*Teste* LeConte.) Original description.

1842. HARRIS, T. W.—*Elater (Melanotus) communis.* Rep. Mass. Ins. Brief description.

1853. LE CONTE, J. L.—*Cratonychus communis.* Trans. Am. Phil. Soc., New Series, X., 477. Description; bibliography; synonymy.

1862. HARRIS, T. W.—*Elater (Melanotus) communis.* Ins. Inj. Veg. 3d ed., p. 55. (See under 1842.)

1867. FITCH, ASA.—*Cratonychus communis.* 11th Rep. N. Y. Ins. pp. 528–530, figs. 13 and 14. Description of imago and larva, in connection with an extended article on wireworms.

1878. THOMAS, CYRUS.—*Melanotus communis.* 7th Rep. St. Ent. Ill., p. 30. Compared to *Melanotis fissilis.* Common in Illinois.

1880. HARRINGTON, W. HAGUE.—Idem. Rep. Ent. Soc. Ont., 1879, p. 83. Common in Canada. Larvæ feed in wood.

1886. FORBES, S. A.—*Melanotus communis.* Bred from INDIAN CORN.

47. MELANOTUS CRIBULOSUS, Lec.

1853. LECONTE, J. L.—*Cratonychus cribulosus.* Trans. Amer. Phil. Soc., X., 478. Original description.

1886. FORBES, S. A.—*Melanotus cribulosus.* Bred from INDIAN CORN.

Family PTINIDÆ.

48. SITODREPA PANICEA, Linn.

1767. LINNÉ, CARL von.—*Dermestes paniceus.* Syst. Nat. Tome. I., Pars. II., ed. 12, p. 561. Original description.

1865. LECONTE, J. L.—*Sitodrepa panicea.* Proc. Acad. Nat. Sci. Phila., 1865, p. 229. (Prodromus of a Monograph of the

Tribe Anobiini, of the Family Ptinidæ, inhabiting North America.) Common throughout the United States and Canada. Synonymy.

1869. PACKARD, A. S., Jr.—Idem. Guide to the Study of Insects, p. 470, fig. 440, pupa. Brief description of imago and larva.

1871. GLOVER, TOWNEND.—Idem. Rep. Com. Agr. 1870, p. 66. Recorded as feeding on kernels of INDIAN CORN.

1881. COMSTOCK, J. HENRY.—Idem. Rep. Com. Agr., 1880, p. 273. The parasite, *Pteromalus calandræ*, Howard, bred from this species.

Family SCARABÆIDÆ.

49. APHODIUS LUTULENTUS, Hald.

1843. HALDEMAN, S. S.—*Aphodius lutulentus.* (Description of North American species of Coleoptera presumed to be undescribed.) Proc. Acad. Nat. Sci. Phila. I., 304. Original description.

1871. HORN, GEO. H.—Idem. Trans. Am. Ent. Soc. III., 124. (Description of the species of Aphodius and Dialytes of the United States.) Description of imago. Occurs in middle and upper Southern States.

1882. RILEY, C. V.—Idem. Rep. Com. Agr., 1881, p. 65. Reported from Missouri as feeding on grains of INDIAN CORN in droppings of cattle.

50. THE ROSE BEETLE.

(*Macrodactylus subspinosus*, Fab.)

1775. FABRICIUS, J. C.—*Melolontha subspinosus.* Syst. Ent., p. 39. (*Teste* Lintner.) Original description.

1826. LOWELL, J.—The Rose Bug. Mass. Agr. Rep. Jour. IX., 143–147. Some remarks on the destructive powers of the rose bug. Occurred on INDIAN CORN.

1851. PRAIRIE FARMER, XI., 335, 386.—Idem. P. 335, statement that this beetle is becoming the worst of all our insect foes. Remedies. P. 386, the appearance and depredations of this insect reported from all directions. Brief account of its life history.

1852. HARRIS, T. W.—*Macrodactylus subspinosus.* Treat. Ins. N. E., p. 30. Brief description of imago. Life history; habits; food plants. Collecting recommended.

1856. FITCH, ASA.—Idem. 2d Rep. N. Y. Ins., pp. 245–252. Quotes Lowell as authority that the beetles were injurious to INDIAN

CORN. Gives an account of food plants and injuries, more especially in relation to fruit-trees. Description of imago. Life history and habits. Natural and artificial remedies.

1862. HARRIS, T. W.—Idem. Insects Injurious to Vegetation, p. 35, fig. 16. (See under 1852.)

1864. GLOVER, TOWNEND.—Idem. Rep. Com. Agr. 1863, pp. 567, 568. Food plants and remedies.

1866. GLOVER, TOWNEND.—Idem. Rep. Com. Agr. 1865, p. 89. Reported from Maryland to be killed in great numbers by the blossoms of the ailanthus tree.

1868. GLOVER, TOWNEND.—Idem. Rep. Com. Agr. 1868, p. 87, fig. 65. Brief history and food plants.

1868. WALSH, B. D. Idem. 1st Rep. St. Ent. Ill., p. 24. Swarms upon grape vines, but prefers the Clinton to all other varieties; a fact which may be taken advantage of to draw the bugs from other vines. Only known remedy practically available, jarring off and destroying.

1869. PACKARD, A. S., Jr.—Idem. Guide to the Study of Insects, p. 454. Brief account of habits and life history.

1873. RILEY, C. V.—Idem. 5th Rep. St. Ent. Mo., pp. 108–110, fig. 39. Injurious to fruit-trees in Kansas. Life history after Harris.

SAUNDERS, W.—Idem. Rep. Ent. Soc. Ont. 1872, pp. 10, 11. Preference for Clinton grape vine a means of lessening their injuries. Walsh quoted on this point. Life history taken from Harris.

1875. COOK, A. J.—The Rose Chafer. Rep. Mich. St. Bd. Agr. 1874, p. 740, fig. 41. Life history and habits briefly given. White hellebore, Paris green, and carbolic acid recommended as remedies.

1876. THOMAS, CYRUS.—Idem. 6th Rep. St. Ent. Ill., p. 103. Specific characters of imago. Habits, life history, and injuries, from Harris.

HORN, Geo. H.—Idem. Trans. Am. Ent. Soc. V., 184. Difference in sexes. Occurs especially in the Northern States northward of a line from Va. to Col.

1878. THOMAS, CYRUS.—The Rose Bug. 7th Rep. St. Ent. Ill., p. 34. When very abundant they occasionally extend their operations to INDIAN CORN. No complaint in this respect has ever been made against them in Illinois.

1880. LINTNER, J. A.—Idem. Country Gent. XLV., 407. Past history; first recorded injuries; food plants and which preferred; life history; bibilography.

1882. LINTNER, J. A.—Idem. 1st. Rep. N. Y. Insects, pp. 227–232. Food plants; injuries; natural history; remedies and preventives. Bibliography.

51. The White Grub.

(*Lachnosterna* sp.)

1842. Harris, T. W.—*Phyllophaga quercina*. Rep. Mass. Ins. Description of imago. Recommends shaking beetles from trees in the morning. May be collected on a cloth and destroyed by throwing into boiling water.

1862. Harris, T. W.—Idem. Insects Injurious to Vegetation, 3d ed, pp. 30, 31, fig. 10. (See under 1842.)

1864. Glover, Townend.—May Beetle.—Rep. Com. Agr. 1863, p. 567. Habits; remedies; natural enemies, etc. Early spring plowing. Use infested land for a hog pasture.

1866. Glover, Townend.—May Bug. Rep. Com. Agr., 1865, p. 38. Found in stomach of woodpecker.

Walsh, B. D.—*Lachnosterna fusca*. Pract. Ent. 1., 60. Three instances cited of injuries to Indian corn. White grub compared to "muck worm". Considers increase of white grub due to the introduction of the improved hog.

1867. Walsh, B. D.—*Lachnosterna quercina*. Prac. Ent. II., 116. Receives specimen of white grub "with a root over an inch long and also a short sprout growing out of the two corners of the mouth," which he supposes to be due to the sprouting of a poisonous seed within the grub. [This is a parasitic fungus.]

Country Gentleman, XXX., 336.—The White Grub. Correspondent states that he has succeeded in repelling grubs by the use of superphosphate of lime.

1869. Packard, A. S., Jr.—*Lachnosterna fusca*. Guide to the Study of Insects, p. 454, figs. 410, 411, larva; 412, side view of pupa. Brief account of habits and injuries.

Riley, C. V.—*Lachnosterna quercina*. 1st Rep. St. Ent. Mo., p. 156, fig. 88. Food plants; remedies; parasitic fungus figured and described; also a very curious fungus reported from Virginia as being parasitic upon the white grub.

1872. Wier, D. B.—Idem. Prairie Farmer, March 9, 1872. Has known it to utterly destroy large fields of corn. Noxious in beetle state, once in three years only. Remedies.

Le Baron, Wm.—Idem. Prairie Farmer, May 12, 1872. Publishes a communication from Prof. T. J. Burrill, in which it is stated that, beyond controversy, the tramping of the surface of the ground on base ball and croquet grounds, and where cattle pastured, saved grass the following year from injury by the white grub. This suggestion of heavy rolling could only apply in case of grasses. Swine and ducks useful in hunting out the grubs.

1873. Packard, A. S., Jr.—The May Beetle. 3d Rep. Mass. Ins. pp. 6–9, fig. 138. Treated in reference to its injuries to the strawberry plant. Habits and life history. Remedies and natural enemies.

RILEY, C. V.—*Lachnosterna, quercina.* 5th Rep. St. Ent. Mo., p. 55. Original description of egg.

1874. RILEY, C. V.—Idem. 6th Rep. St. Ent. Mo., pp. 123–126. Describes larva, cocoons, and imago of *Tiphia inornata*, Say. which insect is parasitic upon the white grub. Also states that he has bred *Rhipiphorus* [*Emmenadia*] *pectinatus* Fab. (var. known as *ventralis*) from *T. inornata.*

1875. COOK, A. J.—The May Beetle. Rep. Mich. St. Bd. Agr., 1874, pp. 111, 112, fig. 6. Natural history and remedies.

1876. THOMAS, CYRUS.—*Phyllophaga fusca.* 6th Rep. St. Ent. Ill. pp. 97–100, fig. 8. Specific characters of imago. Abundance; life history. Term of life in perfect state two or three weeks. Most injurious to INDIAN CORN, wheat, and nurseries following grass of several years standing. Fungus parasite. Remedies. Imago and larva of *Tiphia inornata* described.

1878. THOMAS, CYRUS.—Idem. 7th Rep. St. Ent. Ill. p. 33, fig. 8. Reported instances of injuries to INDIAN CORN in Illinois.

1880. RILEY, C. V.—The White Grub Fungus. American Ent. III., pp. 137–140, figs. 53, 54. Suggests its practical utilization in destroying white grub. Allied species of fungi. Bibliography.

LINTNER, J. A.—*Lachnosterna fusca.* Country Gent XLV., 439. Received specimens of larvæ which were found in stable manure which he identifies as being this species.

1883. B. M. C.—The White Grub. Western Rural, March 10, 1883. Correspondent states that lands well covered with oats or red clover do not have many grubs the next year. Do not eat clover roots or oats as long as there is other food. Does not find grubs in moist land and thinks that is a reason why oats and clover crops are beneficial. He determines what crop to sow by examining the land the autumn previous.

LINTNER, J. A.—Idem. 43d Rep. N. Y. St. Agr. Soc. A general article of eighteen pages.

CLAYPOLE, E. W.—*Lachnosterna fusca.* Rep. Ent. Soc. Ont. 1882, p. 26. Believes moles to be destructive to the larvæ.

52. THE INDIAN CETONIA.

(*Euphoria inda*, Linn.)

1767. LINNÉ, CARL VON.—*Scarabæus indus.* Syst. Nat. 12th ed. Tome. I., Pars. II., p. 556. Original description. Habitat in India.

1823. SAY, THOMAS.—*Cetonia barbata.* Jour. Acad. Nat. Sci. III., 239. Complete writings p. 140. Description of imago. Not uncommon in various parts of our country.

1842. HARRIS, T. W.—*Cetonia inda.* Rep. Mass. Insects. Description of imago. States that they are two-brooded and that the imagos of second brood alight in great numbers, about the middle of September, upon INDIAN CORN stalks, where they feed upon the sweet sap.

1862. HARRIS, T. W.—Idem. Insects Injurious to Vegetation, 3d ed., p. 40, fig. 17. (See under 1842.)

1864. GLOVER, TOWNEND.—Indian Cetonia. Rep. Com. Agr., 1863, p. 568. Brief description. Suggests trapping by hanging in the trees wide-mouthed bottles filled with sweetened water.

1869. GLOVER, TOWNEND.—*Euryomia inda.* Rep. Com. Agr., 1868 p. 90, fig 84. Date of appearance of broods. States the probability that second brood passes the winter in a torpid state.

1874. LE BARON, WILLIAM.—Idem. 5th Rep. St. Ent. Ill., p. 91. Says it sometimes burrows into ripe fruit and also feeds upon SWEET CORN in the milk.

1876. THOMAS, CYRUS.—Idem. 6th Rep. St. Ent. Ill., p. 108. Specific characters of imago. Two broods; times of appearance. Chiefly injurious in beetle state, and especially to peaches.

1877. LINTNER, J. A.—The Indian Cetonia. Country Gent. XLII., 585. A pernicious corn insect. Reported injurious to ears of GREEN CORN.

1879. RILEY, C. V.—*Euryomia inda.* Rep. Com. Agr., 1878, p. 208. States that this species has been received from several correspondents as attacking green corn,—a habit which it was not before known to have, and which has beyond doubt been recently acquired.

1882. LINTNER, J. A.—*Euphoria inda.* Rep. N. Y. Ins. I., 232–239. Bibliography. Complaints received from various sections of New York and New England that this insect is injuring standing INDIAN CORN by burrowing beneath the husks and feeding upon the kernels. Description of imago. Attack probably follows previous injury. Time of its appearance; suggestion as to its larval habits; preventives and remedies.

Family CERAMBYCIDÆ.

53. THE TILE-HORNED PRIONUS.

(*Prionus imbricornis*, Linn.)

1767. LINNE, CARL VON.—*Cerambyx imbricornis.* Syst. Nat. Ed. 12, Tome. I., Pars. II., p. 622. Original description. Habitat Carolina.

1869. RILEY, C. V.—*Orthosoma cylindricum.* 1st Rep. St. Ent. Mo., pp. 124–128, figs. 67, 68, 69. Quotes Mr. I. N. Stuart as

saying that it occurs in the roots of INDIAN CORN stalks. Treats as a grape insect. Describes the larva.

1870. RILEY, C. V.—*Prionus imbricornis*. 2d Rep. St. Ent. Mo., pp. 89–91, fig. 63. States that the larva he described as *Orthosoma cylindricum* is probably that of above species. Gives food habits of two other closely allied species.

1871. GLOVER, TOWNEND.—Idem. Rep. Com. Agr., 1870, p. 72. Gives food plants according to Riley.

1876. THOMAS, CYRUS.—Idem. 6th Rep. St. Ent. Ill., p. 148. Distinguishing characters. Remedies.

Family CHRYSOMELIDÆ.

54. THE CORN ROOT WORM.

(*Diabrotica longicornis*, Say.)

1823. SAY, THOMAS.—*Galleruca longicornis*. Journ. Acad. Nat. Sci. Phila. III., 460. Complete writings II., 223. Original description. Obtained specimens near Rocky Mountains.

1879. RILEY, C. V.—*Diabrotica longicornis*. Rep. Com. Agr., 1878, p. 208. Correspondent from Missouri reports that his INDIAN CORN was seriously damaged by larvæ of this insect.

1880. FRENCH, G. H.—A Corn Insect. Prairie Farmer, Aug. 9. Publishes a letter from Dr. E. R. Boardman, Stark county, Ill., [see following entry] accompanying corn root worms. Describes these briefly, notes their resemblance to larvæ of *Diabrotica vittata* and determines them doubtfully as larvæ of Chrysomelidæ.

BOARDMAN, E. R.—Idem. Prairie Farmer, Aug. 9. In a letter to Prof. French reports serious injury to roots of INDIAN CORN, and sends larvæ evidently responsible for it.

FRENCH, G. H.—The New Corn Insect. Prairie Farmer, Sept. 4. Reports additional letters from Dr. Boardman (see following entry); identifies larva as that of *Diabrotica longicornis* by breeding; and infers from the life history of *D. vittata* that *D. longicornis* will prove to be two- or three-brooded, and that it deposits its eggs at the roots of INDIAN CORN. Discusses clean culture, rotation of crops, and alkaline applications as remedies.

BOARDMAN, E. R.—Idem. Prairie Farmer, Sept. 4. Letters to Prof. French reporting great abundance of *Diabrotica longicornis* in localities infested by the corn root worm, and expressing the belief that the latter is the larva of that species. Gives additional details on life history and extent of injury to INDIAN CORN, and notes abundance of imago on rag weed. Approves rotation of crops and suggests destruction of rag weed as a remedy.

FRENCH, G. H.—The Corn Root Worm. Prairie Farmer, Sept. 18. Reports letters of S. A. Forbes and E. R. Boardman; repeats suggestion of clean culture and rotation of crops; and expresses belief that larvæ will be found feeding upon the roots of Compositæ.

FORBES, S. A.—Idem. Prairie Farmer, Sept. 18. Reports to Prof. French absence of imagos in food of birds, and determines, by dissection, that adults feed upon pollen of thistles.

BOARDMAN, E. R.—Idem. Prairie Farmer, Sept. 18. Gives additional data on life history and injuries to INDIAN CORN; notes damage done by imagos by eating silk and preventing fertilization. Reports that he has found larvæ in roots of rag weed, and thinks proof conclusive that the insect is more than one-brooded.

RILEY, C. V.—*Diabrotica longicornis* Amer. Ent. III., October, p. 247. Date of first receipt of larvæ and pupæ, August, 1874. Invariably found in conjunction with real wireworm, *Drasterius amabilis*, which he believes feeds upon corn root worm. Suggests rotation of crops, destruction of ragweed, and the application of lime and ashes.

WEBSTER, F. M.—More about the New Corn Insect. Prairie Farmer, October 2, 1880. Notes no damage at time of writing, although in cornfields in numbers double that of year preceding. *Leptotrachelus dorsalis* more abundant than formerly.

1881. THOMAS, CYRUS.—*Diabrotica longicornis*. 10th Rep. St. Ent. Ill., pp. 44–46. Contains a letter from Dr. E. R. Boardman, of Stark county, Ill. (See under 1880, French, G. H.) Describes larva and imago; gives distribution; and expresses the opinion that the insect is not likely to prove troublesome.

1882. FRENCH, G. H.—Idem. 11th Rep. St. Ent. Ill., pp. 65–73. Character and amount of injury done as reported by several correspondents. Said to live in roots of ragweed as well as in INDIAN CORN, and thought to be two- or more brooded. Food of imagos. Rotation of crops and clean culture recommended. Description of larva and imago.

SAUNDERS, W.—Idem. Rep. Ent. Soc. Ont., 1881, p. 7. Brief synopsis of the account of this insect in 10th Rep. St. Ent. Ill.

FORBES, S. A.—The Corn Root Worm in McLean County. Bloomington "Leader," September, 1882. Means of identifying the injuries of this insect. Finds it in nearly all the fields of INDIAN CORN visited, retarding growth of plant. Rotation of crops a complete remedy.

FORBES, S. A.—The Corn Root Worm, *Diabrotica longicornis*, Say. Illinois Department of Agriculture, Circular No. 94, Illinois Crops for 1882, p. 122. Reports the recent discovery of the eggs of the imago, and gives first correct statement

of life history. Describes character and amount of injury to INDIAN CORN, and demonstrates sufficiency of rotation of crops as a remedy.

BOARDMAN, E. R.—Economic Entomology. Stark County News, December 21. General article reporting the discovery tha heavy manuring is protection against the injuries of the root worm.

FORBES, S. A.—Idem. Prairie Farmer, December 30. Reports this insect as one of the most destructive enemies o- INDIAN CORN in central Illinois. Gives description and life history of insect, and first figures of egg, imago, and larva; details method, amount, and distribution of injury to corn by larvæ and imagos, and again recommends rotation of crops as a preventive.

1883. FORBES, S. A.—Notes of the Season. Prairie Farmer, Dec. 8. Reports occurrence of larva in roots of sorghum, its absence in broom corn, and continued injury to MAIZE.

POPENOE, E. A.—*Diabrotica longicornis*. Third Biennial Rep. Kan. St. Bd. Agr., VIII., 616. Probable occurrence in Kansas. Brief account of its habits, characters, and of preventive measures.

FORBES, S. A.—Idem. A Lecture on Insects Affecting Corn, pp. 6–12. One-brooded; eggs laid in autumn, hatching June or July following. Larvæ resulting, immediately attack roots of INDIAN CORN. Rotation of crops a thorough safeguard.

FORBES, S. A.—Idem. 12th Rep. St. Ent. Ill., pp. 10–31, figs 1, 2, 3, 4, 5. "A minute, slender, white grub, about two-fifths of an inch long, boring the roots of INDIAN CORN in the ground from June to August, transforming into a grass-green beetle which feeds upon the pollen and silk of the corn, and upon the pollen of other plants." A recent addition to the list of insect pests. Extent and amount of injuries. Imago, pupa, larva, and egg fully described, and life history of each given in detail. Injuries to corn; natural and artificial enemies.

1885. FORBES, S. A.—Idem. 14th Rep. St. Ent. Ill., p. 5. Under head of "Entomological Calendar," states that the corn root worm has continued its injuries, interrupted only by the growing disposition to practice rotation of crops.

55. BROAD-STRIPED FLEA BEETLE.

(*Systena blanda*, Melsh.)

1848. MELSHEIMER, F. E.—*Systena blanda*. Proc. Acad. Nat. Sci. Phila., III., 164. Original description.

1874. GLOVER, TOWNEND. Idem. Rep. Com. Agr. 1873, p. 152, fig. 1. Correspondent writes from Pennsylvania that these beetles

have nearly devastated a field of INDIAN CORN, eating the leave and leaving the bare stalks standing. Brief description of imago.

LE BARON, WM.—Idem. 5th Rep. St. Ent. Ill., p. 173. Descriptive note, with mention of iniuries to young INDIAN CORN in the Middle States.

1884. FORBES, S. A.—Idem. 13th Rep. St. Ent. Ill. p. 86. Already known to be injurious to INDIAN CORN, and found also feeding on strawberry plant.

56. THE BRASSY FLEA BEETLE.

(*Chætocnema pulicaria*, Melsh.)

1848. MELSHEIMER, F. E.—*Chætocnema pulicaria*. Proc. Acad. Nat. Sci. Phila., 1847, p. 167. Original description.

1885. FORBES, S. A.—Idem. 14th Rep. St. Ent. Ill. p. 22. Twice noticed during the season in sufficient numbers to do injury by riddling the leaves of young INDIAN CORN with small holes.

Family TENEBRIONIDÆ.

57. TENEBRIO OBSCURUS, Fab.

1792. FABRICIUS, J. C.—*Tenebrio obscurus*. Ent. Syst. I., 111. Original description.

1870. WALSH & RILEY.—Idem. Amer. Ent. II., 111. Abundance compared to that of *T. molitor*. Introduction into Europe.

1874. LE BARON, WM.—Idem. 5th Rep. St. Ent. Ill. p. 123, fig. 57.

1877. RILEY, C. V.—Idem. 9th Rep. St. Ent. Mo., p. 43. Abundance compared to that of *Tenebrio molitor*.

58. TENEBRIO MOLITOR, Linn.

1767. LINNE, CARL VON.—*Tenebrio molitor*. Syst. Nat. Tome I., Pars II., 12th ed. p. 674. Original description.

1862. HARRIS, T. W.—Idem. Insects Injurious to Vegetation, 3d ed. pp. 10, 11; fig. 1, larva; fig. 2, pupa; fig. 3, imago. Mentioned as a meal worm.

1869. GLOVER, TOWNEND.—Idem. Rep. Com. Agr., 1868, p. 100, fig. 161. Brief description and habits of larva and imago. Injuries compared to those of *T. obscurus*.

PACKARD, A. S., Jr.—Idem. Guide to the Study of Insects, p. 474. Brief description of larva and imago. Found about corn and rye meal.

1870. WALSH AND RILEY.—Idem. Amer. Ent. II., 100. Abundance compared with that of *T. obscurus*.

1874. Le Baron, Wm.—Idem. 5th Rep. St. Ent. Ill., pp. 121, 123, 129. General characters of larva and imago.

1877. Riley, C. V.—Idem. 9th Rep. St. Ent. Mo., p. 43. Abundance compared to that of *T. obscurus*.

Family Meloidæ.

59. The Striped Blister Beetle.

(*Epicauta vittata*, Fab.)

1789. Olivier, A. G.—*Cantharis vittata*. Ins. 46, tab. 1., fig. 3. (*Teste* Fabricius.)

1798. Fabricius, J. C.—*Lytta vittata*. Ent. Syst. Tome I., Pars II., 86. Original description.

1869. Riley, C. V.—Idem. 1st Rep. St. Ent. Mo., p. 96, fig. 39. Treated as a potato insect. Distribution.

1876. Thomas, Cyrus.—*Epicauta vittata*. 6th Rep. St. Ent. Ill., p. 125, fig. 14. Description; distribution. Feeds on potato.

1878. Riley, C. V.—Idem. Rep. U. S. Ent. Com., I., 297. [From Trans. Acad. Sci. St. Louis, Vol. III., 549.] (On the larval characters and habits of the blister beetles belonging to the genera Macrobasis, Lec., and Epicauta, Fab. with remarks on other species of the family Meloidæ.) Larvæ subsist on grasshoppers' eggs.

1880. Riley, C. V.—Idem. Amer. Ent. III., 196. Rep. U. S. Ent. Com. II., 260. Retarded development of this insect.

1883. Forbes, S. A.—Idem. 12th Rep. St. Ent. Ill., p. 104. Seen by Mr. F. M. Webster eating silk from young ears of Indian corn, in August, 1882.

60. The Black Blister Beetle.

(*Epicauta pennsylvanica*, De Geer.)

1775. De Geer, Carl.—*Meloe pennsylvanica*. Ins. V., 16, I., tab. 13, fig. 1. (*Teste* Fabricius.) Original description.

1792. Fabricius, J. C.—*Lytta atrata*. Ent. Syst. Tome I., Pars. II., 86. Description of imago.

1869. Riley, C. V.—Idem. 1st Rep. St. Ent. Mo., p. 98. Treated as a potato insect.

1878. Riley, C. V.—*Epicauta pennsylvanica*. Rep. U. S. Ent. Com. I, 298. Trans. Acad. Sci. St. Louis, Vol. III., 549. (See under previous species, 1878.)

1883. Forbes, S. A.—Idem. 12th Rep. St. Ent. Ill., p. 104. (See under preceding species, 1883.)

Family Otiorhynchidæ.

61. The Imbricated Snout Beetle.

(*Epicærus imbricatus*, Say.)

1823. Say, Thomas.—*Liparus imbricatus*. Journ. Acad. Nat. Sci. Phila. III., 317. Complete writings, II., 178. Original description.

1872. Riley, C. V.—*Epicærus imbricatus*. 3d Rep. St. Ent. Mo., p. 58, fig. 21. Doing considerable damage to fruit trees by gnawing twigs and fruit. Common in Western States.

1876. Thomas, Cyrus.—Idem. 6th Rep. St. Ent. Ill., p. 131. Specific characters of imago. Frequent in Missouri and Iowa. Injuries to fruit.

1880. Comstock, J. Henry.—Idem. Rep. Com. Agr. 1879, p. 249. Correspondent writes from Tennessee that this insect destroyed Indian corn among many other plants.

Riley, C. V.—Idem. Amer. Ent. III., 200, fig. 106. Receives specimens from Delaware, where it destroyed early cabbages eating the leaves and sucking the juice from the stems.

1883. Forbes, S. A.—Idem. 12th Rep. St. Ent. Ill., p. 104. Found feeding on the blossoms of red clover at Normal in June, 1882.

1885. Riley, C. V.—Idem. Rep. Com. Agr. 1884, p. 300. Has received it from Iowa, reported as damaging Indian corn. Treated with reference to its injuries to cabbages.

Family Calandridæ.

62. Sphenophorus pertinax, Oliv.

1789–1808. Olivier, A. G.—*Calandra pertinax*. Ent. V., 83, p. 90, pl. 28, fig. 417. (*Teste* Horn.) Original description.

1873. Horn, G. H.—*Sphenophorus pertinax*. Proc. Amer. Phil. Soc. 1873, p. 418. Description, synonymy, and bibliography. Injurious to Indian corn. Occurs from Canada to Louisiana, and from the Atlantic to the Pacific, and, unfortunately for farmers, is not rare.

1882. Riley, C. V.—Idem. Rep. Com. Agr. 1881, p. 141. This species "has long been known as greatly injurious to Indian corn."

63. The Corn Bill-Bug.

(*Sphenophorus robustus*, Horn.)

1873. Horn, G. H.—*Sphenophorus robustus*. Proc. Amer. Phil. Soc. 1873, p. 419. Original description. Occurs as widely as *S. pertinax*, Oliv, but is less common.

1881. Comstock, J. Henry.—*Sphenophorus pertinax*. Rep. Com. Agr. 1880, p. 272. Received specimens from correspondents in Alabama, where it was said to be injuring young Indian corn extensively, by piercing the stalk just below the ground. Ravages confined to low, wet land.

1882. Riley, C. V.—*Sphenophorus robustus*. Rep. Com. Agr. 1881, pp. 138–142. Pl. viii, fig. 2. Description of imago, larva, and pupa. Habits, natural history, injury, and preventives. Damage is done principally in early spring, as the young Indian corn appears above ground, by puncturing the stalk and sucking the sap.

64. Sphenophorus cariosus, Oliv.

1789–1808. Olivier, A. G.—Ent. V., 83, p. 91, pl. 29, fig. 415. (*Teste* Horn.) Original description.

1871. Glover, Townend.—*Sphenophorus cariosus*. Rep. Com. Agr. 1870, p. 68. Receives this insect from New Jersey, where it is said to be very destructive to young Indian corn plants.

1873. Horn, G. H.—Idem. Proc. Amer. Phil. Soc. 1873, p. 420. Description, synonymy, bibliography. Occurs in Middle States rarely; in Gulf States abundantly.

1876. Le Conte, J. L.—Idem. Proc. Amer. Phil. Soc. XV., 425. (The Rhyncophora of America.) Favors uniting *S. callosus* Oliv. with above species.

65. The Sculptured Corn Curculio.

(*Sphenophorus sculptilis*, Uhler.)

1855. Uhler, P. R.—*Sphenophorus sculptilis*. Proc. Acad. Nat. Sci. Phila. VII., 416. (A description of a few species of Coleoptera supposed to be new.) Original description.

1857. Fitch, Asa.—*Sphenophorus venatus*. The Cultivator, 3d series, V., 273. Receives specimens from correspondents in New York State, where it is seriously injuring Indian corn. Collecting the beetles the most effectual remedy.

1867. Walsh, B. D.—*Sphenophorus zeæ*. Pract. Ent. II., 117. Reported from New York State as making sad havoc with Indian corn, destroying whole fields in some instances. Redescribed as a new species.

1871. RILEY, C. V.—Idem. 3d Rep. St. Ent. Mo., p. 59, fig. 22. Description and brief account of its habits,—after Walsh.

1873. HORN, G. H.—Idem. Proc. Amer. Phil. Soc., 1873, p. 423. Description of imago. Bibliography. Occurs in Middle States, Georgia, and Kansas.

HORN, G. H.—*Sphenophorus sculptilis*. Proc. Amer. Phil. Soc. 1873, p. 423. Description of imago. Middle, Western, and Southern States.

1876. LE CONTE, J. L.—Idem. Proc. Amer. Phil. Soc. XV., 425. Unites *S. zeæ*, Walsh, with this species.

1877. PACKARD, A. S., Jr.—*Sphenophorus zeæ*. Hayden, Rep. IX., U. S. G. G. Surv. Terr., 1875, p. 718. Description, injuries, and remedies. Detected this species at Hyannis, Massachusetts, June 25.

1878. THOMAS, CYRUS.—Idem. 7th Rep. St. Ent. Ill., p. 34. Description of imago and brief account of habits,—after Walsh.

1879. COMSTOCK, J. HENRY.—Idem. Rep. Com. Agr., 1879, p. 248. Receives specimens of this species from Missouri, where it destroyed two plantings of INDIAN CORN and injured the third. The corn was in dry land, sufficiently rolling to drain well.

1879. LINTNER, J. A.—Idem. Country Gent. XLIV., 439. Description and distribution. Received specimens of this insect from New Jersey where it is reported to be injuring INDIAN CORN. Account of some recorded injuries.

1881. COMSTOCK, J. HENRY.—*Sphenophorus sculptilis*. Rep. Com. Agr., 1880, p. 272. Received specimens from South Carolina, where they were represented as injuring young INDIAN CORN by piercing the stalk at or above the surface of the ground.

1882. RILEY, C. V.—Idem. Rep. Com. Agr., 1881, p. 139. Occurs in the South and West and is common in Illinois and Missouri. Has been received from Florida and Alabama as injuring INDIAN CORN.

LINTNER, J. A.—Idem. 2d Rep. N. Y. Insects, pp. 253-263, fig. 76. Received specimens from New Jersey, where they caused serious injury to INDIAN CORN. Gives synonymy; description of imago; recorded injuries; distribution; breeding ground; original food plant; and food plants and habits of allied species. Testimony concerning the presence of curculio larvæ in the stems of INDIAN CORN; probably unsuspected cause of much injury to it. Remedies.

1885. LINTNER, J. A.—Idem. 2d Rep. N. Y. Insects, p. 52. Some account of its early history in New York. Correspondent from Kansas believes the larvæ to be lignivorous.

66. Sphenophorus parvulus, Gyll.

1826. Gyllenhal, L.—*Sphenophorus parvulus*. Schönh Gen. Curc. IV., 961. Original description.

1873. Horn, G. H.—Idem. Proc. Am. Phil. Soc. 1873, p. 427. Description of imago. Occurs in Pennsylvania, Georgia, and Kansas.

1882. Riley, C. V.—Idem. Rep. Com. Agr. 1881, p. 139. Received from Missouri as injuring Indian corn.

67. The Rice Weevil.

(*Calandra oryzæ*, Linn.)

1766. Linne, Carl von.—*Curculio oryzæ*. Amoen. Ac. VI., 395. (*Teste* Horn.) Original description.

1842. Harris, T. W.—*Calandra oryzæ*. Rep. Mass. Insects. Injurious to Indian corn in Southern States. Description, habits, life history. Appearance in spring. Recommends collecting them by winnowing the rice which they attack.

1861. Coble, John A. M.—Black Weevil. Cultivator, 3d series, IX., 83. Writes from North Carolina that he has used salt effectually against this pest.

1862. Hyrris, T. W.—*Calandra oryzæ*. Insects Injurious to Vegetation 3d ed., p. 83, pl. II, fig. 8. (See under 1842.)

1864. Glover, Townend.—Southern Rice Weevil. Rep. Com. Agr. 1863, p, 572. Compares it briefly with *Calandra granaria*. and suggests frequent stirring and kiln-drying as remedies.

1869. Packard, A. S., Jr.—*Sitophilus oryzæ*. Guide to the Study of Insects, p. 490, fig. 437, *c*. Brief mention.

1873. Horn. G. H.—*Calandra oryzæ*. Proc. Am. Phil. Soc. 1873, p. 430. Description of imago. Bibliography. Says this species occurs in all parts of the world.

1881. Comstock, J. Henry.—Idem. Rep. Com. Agr. 1880, p. 273. Two chalcids bred from this species and described by Mr. L. O. Howard as *Pteromalus calandræ*.

Thomas, Cyrus.—*Sitophilus oryzæ*. Farmer and Fruit Grower, July 27, 1881. Injurious to wheat in Southern Illinois. Believes that the cold winter succeeding has destroyed the insects.

1882. Forbes, S. A.—Idem. Farmers' Review. Dec. 1, 1882. Mention.

1885. Riley, C. V.—*Calandra oryzæ*. Rep. Com. Agr., 1884, p. 414. Correspondent from Florida suggests cribbing corn with the shuck on as a safeguard against this insect.

68. The Grain Weevil.

(*Calandra granaria*, Linn.)

1767. Linne, Carl von.—*Curculio granarius*. Syst. Nat. 12th ed., Tome I., Par. II., 608. Original description.

1842. Harris, T. W.—*Calandra granaria*. Rep. Mass. Insects. Description, life history, power of multiplication, remedy.

1862. Harris, T. W.—Idem. Insects Injurious to Vegetation, 3d ed., p. 83. (See under 1842.)

1864. Glover, Townend.—Northern Granary Weevil. Rep. Com. Agr. 1863, p. 572. Compares it to Southern rice weevil, and suggests remedies.

1869. Walsh and Riley.—*Sitophilus granarius*. Amer. Ent. I., 179. Insect may be used for blistering. Suggest care in use of grain attacked by it.

Packard, A. S., Jr.—Idem. Guide to the Study of Insects, p. 489, fig. 467, *e*. Brief mention of habits and injury.

1876. Western Farm Journal, June 16.—Corn Weevils in Foreign Grain. Foreign Indian corn infested by weevils at Philadelphia Exposition.

1880. Riley, C. V.—Grain Weevils. Amer. Ent. III., 26. Quotes a French journal as saying that these insects were attracted to a tub of anise seed, and thereby killed.

Elliot, A. T.—Idem. Amer. Ent. III., 179. Reports an instance of the effectual use of pyrethrum in destroying this insect.

Rilliet, Chas.—*Butalis granaria*. Rural New Yorker, May 1, 1880. Reports from Lake county, Illinois, an instance of severe injury to unthreshed wheat, while similar wheat in granary was uninjured.

1882. Forbes, S. A.—*Sitophilus granaria*. Farmers' Review, December 1, 1882. Brief account of habits and remedies, in reply to an inquiry from Missouri.

Order HEMIPTERA.

Family Lygæidæ.

69. The Chinch Bug.

(*Blissus leucopterus*, Say.)

1831. Say, Thomas.—*Lygæus leucopterus*. (Descriptions of new species of Heteropterous Hemiptera of North America. Transactions of the New York State Agricultural Society, p. 774. Complete writings, I., 329. Original description. Described from single specimen taken in Virginia.

1845. PRAIRIE FARMER, V., 227. Injuries in Hancock county, Illinois.

PRAIRIE FARMER, V., 287.—Chinch Bugs. Injuries in Tazewell county, Illinois. An account of their season's history.

1846. PRAIRIE FARMER, VI., 184.—The Chinch Bug. Injuries in Sangamon county, Illinois.

PRAIRIE FARMER, VI., 245.—Chinch Bugs. Injuries in Cass county, Illinois.

1850. LEBARON, WM.—*Rhyparochromus devastator*. Prairie Farmer, X., 200. Description of imago, nomenclature, habits, life history, and injuries.

1851. PRAIRIE FARMER, XI., 335.—The Chinch Bug. Distribution within the State of Illinois.

1852. HARRIS, T. W. *Rhyparochromus leucopterus*. Treatise Insects Massachusetts. Brief description of imago, distribution and injuries.

1855. FITCH, ASA.—*Micropus leucopterus*. The Cultivator, 3d series, III., 237-239. Correspondent writes from Indiana giving account of habits and injuries. Past history and nomenclature.

1856. FITCH, ASA.—Idem. 2d Rep. Ins. N. Y., pp. 277-297. Its first appearance; appearance in 1839 in North Carolina and in Illinois; its destructiveness, distribution, nomenclature, remedies.

1862. HARRIS, T. W.—*Rhyparochromus leucopterus*. Insects Injurious to Vegetation. 3d ed., pp. 197-200, fig. 84. (See under 1852.)

1866. WALSH, B. D.—Chinch Bugs. Pract. Ent., I., 95. Reports a case of the prevention of injuries by surrounding INDIAN CORN field with a barrier of pine boards set up edgewise and keeping the upper edge moist with coal-tar.

WALSH, B. D.—*Micropus* (*Lygæus*) *leucopterus*. Pract. Ent. II., 21. Receives specimens from Canada whose wings are half the length of the body, and infers that they are a geographical variety.

1868. SHIMER, HENRY.—*Blissus leucopterus*. Proc. Acad. Nat. Sci. Phila., XIX., 75-80. Notes on *Micropus* (*Lygæus*) *leucopterus* with an account of the great epidemic among these insects in 1865. Gives an account of their abundance and habits in 1864.

1869. WALSH AND RILEY.—*Micropus leucopterus*. Amer. Ent. I., 169, 177, 194, 193, figs. 122, 138, 139. Past history; natural history. Natural checks: heavy rains, cannibal foes. Injuries; remedies. Four points thought to be established: 1st, chinch bugs hibernate in the winged state in any dry rubbish, hence such material should be burned in the spring; 2d, the earlier small grain can be sown the more likely it is to escape the chinch bug; 3d, the harder the ground when the grain is sowed, the less injury; 4th, a single heavy rain immediately checks the propagation of the chinch bugs.

PACKARD, A. S., Jr.—*Blissus leucopterus.* Guide to the Study of Insects, pp. 543, 544, fig. 547. Description of imago; habits, injuries, epidemic disease of 1865, remedies.

1870. RILEY, C. V.—*Micropus leucopterus.* 2d Rep. St. Ent. Mo., pp. 15–47, figs. 1, 2. (See under 1869, Walsh and Riley.)

1871. GLOVER, TOWNEND.—*Rhyparochromus* (*Micropus*) *leucopterus.* Rep. Com. Agr. 1870, p. 89. Deposition and hatching of eggs. Mode of injury. Two broods annually, perhaps three in the South. Most destructive in hot, dry summers. Early grain most likely to escape their ravages. Remedies.

1872. BETHUNE, C. J. S.—*Micropus leucopterus.* Rep. Ent. Soc. Ont., 1871, p. 55. Past history and injuries, description, natural and artificial remedies.

LE BARON, WM.—Idem. 3d Rep. St. Ent. Mo., pp. 142–156. Excessive prevalence in 1871. Methods and agencies for their destruction. Natural enemies. Anticipating ravages by sowing grain early; saving crop by preventing migrations of insect; destroying by burning rubbish in fall; preventing breeding of insect by abstaining from the cultivation of those grains upon which they chiefly subsist.

LE BARON, WM.—Chinch Bug. Experience of 1872. Prairie Farmer, August 24, 1872. Believes that a sufficient number of these insects hibernate under dead leaves in the woods to perpetuate the species; also that the wet spring of 1872 destroyed large numbers of the chinch bugs.

GLOVER, TOWNEND.—*Rhyparochromus leucopterus.* Rep. Com. Agr. 1871–72, p. 84. Localities in which it is injurious.

GLOVER, TOWNEND.—*Micropus* (*Rhyparochromus*) *leucopterus.* Rep. Com. Agr. 1872, p. 121. Especially destructive to sorghum in a few counties in Ohio, Indiana, Missouri, and Kansas, and to wheat in other counties of the same States. In Crawford county, Mo., three distinct broods noticed, appearing, respectively, first of May, last of June, last of August. INDIAN CORN in milk at last visitation, and it was seriously injured.

1874. B. F. J. [JOHNSON.]—Chinch Bug. Country Gent. XXXIX., 661. So abundant upon green corn fodder in central Illinois as to be seriously injurious to the health of horses and cattle, and in some cases caused their death.

1875. GLOVER, TOWNEND.—*Micropus* (*Rhyparochromus*) *leucopterus.* Rep. Com. Agr. 1874, p. 127. Localities in which it is injurious.

EVEREST, H. J.—*Blissus leucopterus.* Western Rural, July 17. Barricading with boards and coal tar.

RILEY, C. V.—*Micropus leucopterus.* 7th Rep. State Ent. Mo., pp. 19–50, figs. 2, 3, 4. Description of egg, larval stages, pupa, and imago. Past history; destructive powers; injuries in 1874; food plants; mode of reproduction and hibernation; disposition of eggs; flight. Remedial agencies exhaustively treated.

1876. Uhler, P. R.—*Blissus leucopterus*. List of Hemiptera west of the Mississippi river, p. 40. Distribution in United States.

1878. Thomas, Cyrus.—Idem. 7th Rep. St. Ent. Ill., pp. 40–71, fig. 10. Description of its various stages. Extended account of injuries. Two broods in northern Illinois; some evidence of a third in extreme southern Illinois. Hibernation; migrations; natural agencies which assist in their destruction; remedies, followed by account of proposed remedies as given by LeBaron in 8d Rep. St. Ent. Ill., p. 144.

1879. Thomas, Cyrus.—Idem. Bul. U. S. Ent. Com. No. 5. Ten figures and map showing distribution. A *resumé* of the present knowledge of its history, characters, and habits, and the means of destroying it or lessening its injuries.

1880. Thomas, Cyrus.—Temperature and Rainfall as affecting the Chinch Bug. Periodicity in its increase. Amer. Ent. III., 240–242.

1881. Thomas, Cyrus.—The Relation of Meteorological Conditions to Insect Development. 10th Rep. St. Ent. Ill., pp. 47–59. Believes there will be but two chinch bug years in seven, corresponding to certain meteorological conditions.

The Farmers' Review, July 21, 1881.—The Chinch Bug Pest. Wide-spread complaint of injuries from this pest the current season. Damage most severe on old land. Fertilizers a protection against ravages of the chinch bug.

1882. Riley, C. V.—Chinch Bug Notes. Rep. Com. Agr., 1881, pp. 87–89. Predictions in relation to injury. Injury in spring of 1882. Remedies and preventive measures—irrigation mentioned.

Forbes, S. A.—The Chinch Bug in 1882. St. Dept. Agr., Circular No. 92, Illinois Crop Prospects, August 1, p. 77. Reports apparent retardation of hatching and unusual method of attack due to extraordinarily cold, wet, and late spring. Determines experimentally that wet weather takes no injurious effect upon adults. Finds small brown ant, *Lasius alienus*, attending young chinch bugs and feeding upon their fluid excrement. Determines by dissection that a predaceous beetle (*Agonoderus comma*) feeds upon the young. Reports presence of bacterial disease among chinch bugs. Mentions successful experiments for killing chinch bugs with kerosene emulsion, at a cost of about three fourths of a cent per gallon.

1882. Forbes, S. A.—Bacterium, a Parasite of the Chinch Bug. Amer. Nat. XVI., (Oct.) p. 824. Gives account of discovery of parasitic disease among chinch bugs, with observations and experiments indicating its connection with a Bacterium found in the alimentary canal.

Forbes, S. A.—Another Chinch Bug Parasite. Prairie Farmer, Dec. 9, 1882. Brief account of a fungus found destroying chinch bugs in corn fields near Jacksonville, Ill. Mention also of the Bacterium parasite *Micrococcus insectorum*, Burrill. Predicts immunity from the chinch bug in 1883.

1883. FORBES, S. A.—Studies on the Chinch Bug (*Blissus leucopterus*, Say.) 12th Rep. St. Ent. Ill., pp. 32–63, figs. 6, 7. Life history. Natural enemies: insects, birds, and microscopic parasites. Elaborate account of bacterial disease. Topical applications; experiments with them reported. A mechanical mixture of water and three per cent. of kerosene is deadly to chinch bugs of all ages.

FORBES, S. A.—A Lecture on Insects affecting corn, pp. 19, 20. Brief account of life history, effects of weather, remedial measures, insect enemies, and contagious diseases.

FORBES, S. A.—Experiments on the Chinch Bug. Rep. U. S. Dept. Agr., Div. Ent., Bul. No. 2, pp. 23–25. Memoranda of experiments relating to use of kerosene emulsions on chinch bugs.

FORBES, S. A.—Entomological Notes of the Season. St. Dept. Agr., Circular No. 106, Illinois Crops for 1883, p. 177. Reports deposit, in spring, of eggs of first brood about the roots of INDIAN CORN.

LINTNER, J. A.—The Chinch Bug. Albany Argus, Oct. 10, 1883. Its ravages in northern New York; habitat; method of attack and destructiveness; how to combat it.

LINTNER, J. A.—The Chinch Bug in New York. Country Gent., Nov. 8, 1883. Directions for coöperation against the insect in New York State.

1884. SAUNDERS, W.—*Micropus leucopterus*. Rep. Ent. Soc. Ont., 1883, pp. 59–62. Its appearance in New York State and a general account of the insect,—principally after Lintner.

1885. LINTNER, J. A.—*Blissus leucopterus*. 2d Rep. Insects N. Y., pp. 148–164. Description; bibliography; history; transformations; early brood; second brood; hibernation; dimorphic form; injuries; operations in New York; measures recommended to arrest the attack, etc.

BRUNER, LAWRENCE.—Idem. Rep. Com. Agr., 1884, p. 389. An instance of the sudden disappearance of vast armies of this insect immediately after several heavy rains.

RILEY, C. V.—Chinch Bug Notes. Rep. Com. Agr., 1884, pp. 493, 405. Injuries in New York State in 1882. Different views of the origin of the outbreak discussed.

Family TETTIGONIDÆ.

LEAF HOPPERS.

70. JASSUS INIMICUS, SAY.

1831. SAY, THOMAS.—*Jassus inimicus*. Jour. Acad. Nat. Sci. Phila. VI., 305. Complete writings, II., 382. Original description. Reported from Virginia as depredating on the roots of wheat.

1885. FORBES, S. A.—Idem. 14th Rep. St. Ent. Ill. pp. 22, 67. Has occasionally occurred in June and July in sufficient numbers to injure young INDIAN CORN appreciably.

71. CICADULA NIGRIFRONS, Forbes.

1885. FORBES, S. A.—*Cicadula nigrifrons* 14th Rep. St. Ent. Ill., pp. 22, 67, pl. v, fig. 3. Original description. Food plants: wheat and INDIAN CORN. Occasionally in sufficient numbers to injure latter.

72. CICADULA QUADRILINEATUS, Forbes.

1885. FORBES, S. A.—*Cicadula quadrilineatus*. 14th Rep. St. Ent. Ill., pp. 22, 68, pl. v, fig. 4. Original description. Food plants: wheat and INDIAN CORN. Occasionally in sufficient numbers to injure INDIAN CORN.

73. MACROPSIS NOBILIS.

1885. FORBES, S. A.—*Macropsis nobilis*. 14th Rep. St. Ent. Ill., p. 22. Occasionally occurs in sufficient numbers, in June and July, to injure young INDIAN CORN plants.

Family APHIDIDÆ.

74. THE CORN PLANT LOUSE.

(*Aphis maidis*, Fitch.)

1856. FITCH, ASA.—*Aphis maidis*. 2d Rep. Ins. N. Y. pp. 318–320. Original description of ærial larva and wingless and winged females. Mentions the occurrence of the ærial form on INDIAN CORN and predicts that it will probably multiply at times sufficiently to do much injury.

1863. WALSH, B. D.—Idem. Proc. Ent. Soc. Phila., I., 300 wingless ♀ fig. 3, winged ♀ fig. 1. (On the genera of Aphidæ found in the United States.) Description of wingless and winged females of root form.

1865. WALSH, B. D.—The Corn Root Louse. Trans. Ill. St. Agr. Soc. V., pp. 491–497. (A New Enemy of the Corn.) Relation of ants to plant lice. Occurrence of corn plant louse near Rock Island.

1878. THOMAS, CYRUS.—*Aphis maidis*. 7th Rep. St. Ent. Ill., pp. 75–78, fig. 18. Description of wingless and winged individuals found on tassels. Statement from correspondents as to injuries. Remedies.

1880. THOMAS, CYRUS.—Corn Aphis. 9th Rep. St. Ent. Ill., p. 2. Root form most injurious. Recommends rotation of crops, thorough fall plowing and turning under strong lime.

1882. BOARDMAN, E. R.—*Aphis maidis*. Stark County News. General accounts of its life history. Rotation advocated as the most effectual remedy.

1883. FORBES, S. A.—Idem. A Lecture on Insects Affecting Corn, pp. 12–14. Relation of ants to corn plant lice. Known life history.

POPENOE, E. A.—The Corn Plant Louse on Cane. 3d Biennial Rep. St. Bd. Agr. Kan., VIII., 617. Relation of the

larvæ of Syrphus fly to corn plant louse. Injurious to sorghum in Kansas.

FORBES, S. A.—*Aphis maidis*. 12th Rep. St. Ent. Ill., pp. 44, 116. Ants (*Lasius flavus* [*alienus*]) caring for corn plant lice. *Megilla maculata*, *Hippodamiga convergens* and *H. glacialis* as enemies.

1884. FORBES, S. A.—Idem. 13th Rep. St. Ent. Ill., pp. 46–50, pl. III, fig. 5; pl IV, figs. 1, 2, 3. Treated in reference to its injuries to sorghum and broom corn. Description of imago; life history; natural enemies and remedies.

1885. GARMAN, H.—Idem. 14th Rep. St. Ent. Ill., pp. 23–33. Description of pupæ and winged and wingless females of both root and ærial forms. Suggests various theories of hibernation. Life history and habits. Parasites and predaceous insect enemies, and artificial remedies.

ORDER ORTHOPTERA.

Family GRYLLIDÆ.

75. THE WESTERN CRICKET.

(*Anabrus simplex*, Hald.)

1852. HALDEMAN, S. S.—*Anabrus simplex*. Stanbury's Expedition to the Great Salt Lake, p. 372, pl. x, fig. 4. Original description. States that it seemed to be one of the species eaten by the aborigines.

1877. PACKARD, A. S., Jr.—Idem. 9th Rep. U. S. G. G. Surv. Terr. pp. 691–693. Description of imago. Injuries to INDIAN CORN. Preventive measures.

1880. PACKARD, A. S., Jr.—Idem. 22d Rep. U. S. Ent. Com. pp. 163–178, figs, 2, 3, 4, 5. Habits and ravages; food; predaceous enemies and internal parasites; breeding habits; remedies; distribution; distinguishing characters; anatomy.

1883. BRUNER, LAWRENCE.—Idem. 3d Rep. U. S. Ent. Com. pp. 61–64. Ravages, habits and natural history. Breeding habits; distribution; parasites.

Family LOCUSTIDÆ.

76. ORCHELIMUM VULGARE, Harr.

1842. HARRIS, T. W.—*Orchelimum vulgare*. Rep. Mass. Ins., p. 130. Original description.

1862. HARRIS, T. W.—*Idem*. Insects Injurious to Vegetation, 3d ed., pp. 161, 162, fig. 77. (See under 1842.)

1863. RATHVON, S. S.—Idem. Rep. Com. Agr. 1862, p. 382. Brief description of imago. Abundant species.

1869. PACKARD, A. S., Jr.—Idem. Guide to the Study of Insects. p. 567. Brief description of imago. Common northward.

1885. FORBES, S. A.—Idem. 14th Rep. St. Ent. Ill., p. 23. Injury to INDIAN CORN in Southern Illinois.

Family ACRIDIDÆ.

77. THE RED-LEGGED LOCUST.

(*Pezotettix femur-rubrum*, DeG.)

1773. DE GEER, CARL.—*Acridium femur-rubrum*. Mem. pour Serv., p. 498, pl. 42, fig. 5. Original description.

1842. HARRIS, T. W.—*Acrydium femur-rubrum*. Rep. Mass. Ins. Description of imago, and brief account of habits, life history, and injuries.

1862. HARRIS, T. W.—Idem. Insects Injurious to Vegetation, 3d ed., p. 174. (See under 1842.)

1865. THOMAS, CYRUS.—*Acridium femur-rubrum*. Trans. Ill. St. Bd. Agr. V., 451. Description of imago; habits; and distribution.

1868. WALSH and RILEY.—*Caloptenus femur-rubrum*. Amer. Ent. I., 16. Abundance in Illinois in 1868.

1868. WALSH, B. D.—Idem. 1st Rep. St. Ent. Ill., pp. 99–101. Compared to *Caloptenus spretus*. Injuries to INDIAN CORN. Occurrence and past history in Illinois.

1869. PACKARD, A. S., Jr.—Idem. Guide to the Study of Insects, pp. 569, 570, fig. 564b. Abundance and distribution.

1872. LEBARON, WM.—Idem. 3d Rep. St. Ent. Ill., p. 157. Account of a parasitic mite.

1873. THOMAS, CYRUS.—Idem. Rep. U. S. Geol. Surv. Terr. V., Part I., 163. (Synopsis of the Acrididæ of N. A.) Description of imago. Distribution.

1875. GLOVER, TOWNEND.—Idem. Rep. Com. Agr. 1874, pp. 126, 136. Occurrence and damage in Eastern States.

1877. THOMAS, CYRUS.—Idem. 6th Rep. St. Ent. Ill., p. 45. Replaced in Illinois during season of 1875 by *Caloptenus atlanis*.

1878. RILEY, C. V.—Idem. 1st Annual Rep. U. S. Ent. Com., pp. 443–448. Migratory habit, distribution, and injuries.

THOMAS, CYRUS.—Idem. 7th Rep. St. Ent. Ill., pp. 38–40. Description of male and female, and comparison with *Caloptenus spretus*.

1880. THOMAS, CYRUS.—Idem. 9th Rep. St. Ent. Ent. Ill., pp. 124–126, 131–140. Description of male and female; life history; injuries; remedial agencies.

1885. FORBES, S. A.—*Pezotettix femur-rubrum*. 14th Rep. St. Ent. Ill., p. 23. Injury to INDIAN CORN.

78 The Lesser Locust.

(*Pezotettix atlanis*, Riley.)

1875. Riley, C. V.—*Caloptenus atlanis*. 7th Rep. St. Ent. Mo., p. 169. Original description.

1878. Riley, C. V.—Idem. 1st Annual Rep. U. S. Ent. Com. pp. 443–448. Flights; injuries; distribution; migratory habits.

Thomas, Cyrus.—Idem. 7th Rep. St. Ent. Ill., p. 38. Description of imago. Comparison to allied forms.

1884. Riley, C. V.—Idem. Rep. Com. Agr. 1883, pp. 170–180. Its ravages in New Hampshire. Past History. Injury to corn. Characters; range and life history; natural enemies; remedies.

1885. Forbes, S. A.—*Pezotettix atlanis*. 14th Rep. St. Ent. Ill., p. 23. Injury to Indian corn.

79. The Rocky Mountain Locust.

(*Pezotettix spretus*, Thos.)

1865. Thomas, Cyrus.—*Acridium spretis*. Trans. Ill. St. Agr. Soc. V., 450. Original description.

1867. Glover, Townend.—*Caloptenus spretus*. Rep. Com. Agr. 1866, pp. 27, 28. Injuries in Kansas. Letters of inquiry and answers.

1868. Walsh, B. D.—Idem. Pract. Ent. II., 1–5, and 22. (Grasshoppers and Locusts.) First specifically recognizable mention of this species. Its ravages and migrations; probable limit of its range; preventing its increase. Injuries to Indian corn, pp. 3 and 4.

Nickerson, M. C. "Grasshoppers." Am. Ent. I., 27. (Devastations in western Iowa, and the good that resulted from them.) Destroyed late planted Indian corn. Seeds of *Vilfa vaginæflora* imported by them.

Walsh, B. D.—*Caloptenus spretus*. 1st Rep. St. Ent. Ill., pp. 82–103. Eastern limit of the range of the locust. Occurrence and ravages in Texas and Missouri in 1866, and in the Mississippi Valley in 1867. Past history; compared to *C. femur-rubrum*. Injuries to Indian corn, pp. 88, 90, 95.

Walsh and Riley.—Idem. Amer. Ent. I., pp. 73–76, fig. 65. Distinguished from *C. femur-rubrum*. Its native haunts, migrations, geographical range, and ravages.

1869. Packard, A. S., Jr.—Idem. Guide to the Study of Insects, p. 570, fig. 564a. Abundance, distribution, and ravages.

Byers, W. N.—The "Colorado Grasshopper." Amer. Ent. I., pp. 94, 95. Native haunts, migrations, ravages, and enemies.

1873. Thomas, Cyrus.—*Caloptenus spretus*. Rep. U. S. Geol. Surv. Terr. V., Part I., 164. (Synopsis of the Acrididæ of North America.) Description of the imago. Distribution.

1875. RILEY, C. V.—Idem. 7th Rep. St. Ent. Mo., pp. 121–196, figs. 23–39. Its characters; natural and chronological history; habits; ravages; predaceous enemies and parasites; home; migrations and geographical distribution; means of preventing its ravages. Injuries to INDIAN CORN, pp. 146, 150, 152. Food plants, 158.

THOMAS, CYRUS.—Idem. Daily Inter Ocean, October 9, 1875. Origin and movements; hatching grounds and highways on our western frontiers; means of counteracting their inroads.

GLOVER, TOWNEND.—Idem. Rep. Com. Agr. 1874, pp. 125, 126, 136, 137. Injury and suffering caused.

BETHUNE, C. J. S.—Idem. Rep. Ent. Soc. Ont. 1874, pp. 29–42, figs. 30–34. Past history. Plague of 1874. Locust in Manitoba. Description of imago compared to *C. femur-rubrum*. Means of reducing its ravages.

1876. BETHUNE, C. J. S.—Idem. Rep. Ent. Soc. Ont., 1875, pp. 45–54. Compiled account of its occurrence and doings in 1875. Extracts from Riley's Eigth Report on means of reducing ravages, etc.

RILEY, C. V.—Idem. 8th Rep. St. Ent. Mo., pp. 57–156, figs. 39–47. Detailed account of its ravages in Missouri and neighboring states in 1875. Natural history of young; definition of the species; its native home; migrations and ravages; compensations that follow their ravages; natural and artificial means of reducing them. Use of locusts as food.

1877. RILEY, C. V.—Idem. 9th Rep. St. Ent. Mo., pp. 57–124, figs. 16–29. Its doings in 1876 in the northern and western states and territories of the Mississippi Valley. Detailed reports from counties in Missouri. Source of the swarms of 1876; direction, rate, and extent of their flight. Geographical range and that of its allies. How the eggs are laid and hatched. Predaceous enemies and parasites. Experiments to determine the best artificial means of reducing its ravages. Legislation on the subject by Missouri, Kansas, and Minnesota. Injuries to INDIAN CORN, pp. 63, 64, 65.

PACKARD, A. S., Jr.—Idem. 9th Rep. U. S. G. G. Surv. Terr., pp. 591-684. Their occurrence and ravages in Colorado, Kansas, Wyoming, Utah, New Mexico, and Nevada. Their northern range; their invasion in 1876; their habits, seasons, and development. Classificatory characters, geographical distribution and migrations; external enemies and parasites. Preventive measures; summary of our present knowledge. Meteorological data.

THOMAS, CYRUS.—Idem.—6th Rep. St. Ent. Ill., pp. 44–56. Its invasions and migrations; extent of hatching ground; remedial agencies. Injuries to INDIAN CORN, p. 51.

1878. RILEY, PACKARD, AND THOMAS.—Idem. 1st Annual Rep. U. S. Ent. Com. An elaborate treatment of the subject, with a consideration of the best means of preventing the injuries and guarding against the invasions of the insect.

THOMAS, CYRUS.—Idem. 7th Rep. St. Ent. Ill., pp. 36-38, fig. 8. Description of male and female, and comparison with allied forms.

1880. THOMAS, CYRUS.—Idem. 9th Rep. St. Ent. Ill., pp. 121-123, figs. 19, 20, 21. (Acrididæ of Illinois.) (See under 1878.)

RILEY, PACKARD, AND THOMAS.—Idem. 2d Annual Rep. U. S. Ent. Com. Additions to the chronology of ravages, and their relation to agriculture and the settlement of the territories. Meteorological influences. Southern limits of distribution. Summary of locusts' flights. The air sacs of locusts with reference to their powers of flight. Histology of the brain, further facts about natural enemies. Courses that may be adopted by general government to lessen injury.

1883. BRUNER, LAWRENCE.—Idem. 3d Rep. U. S. Ent. Com., pp. 8-52. Occurrence in Montana in 1880; in Wyoming, Montana, etc., in 1881.

1885. BRUNER, LAWRENCE.—Idem. Rep. Com. Agr., 1884, p. 398. Occurrence in Nebraska in 1884.

80. PEZOTETTIX DIFFERENTIALIS, Thos.

1865. THOMAS, CYRUS.—*Acridium differentialis*. Trans. Ill. St. Agr. Soc., V., 450. Original description.

1868. WALSH & RILEY.—*Caloptenus differentialis*. Amer. Ent., I., 16. Abundance in Illinois in 1868, and its replacement by *Caloptenus bivittatus* in vicinity of Chicago.

1871. THOMAS, CYRUS.—Idem. Proc. Acad. Nat. Sci. Phila., 1871, p. 149. Species more fully described, male and female.

1873. THOMAS, CYRUS.—Idem. Rep. U. S. Geol. Surv. Terr. V., Part I., p. 166. (Synopsis of the Acrididæ of N. A.) Description of imago, and distribution.

1875. THOMAS, CYRUS.—Idem. Daily Inter Ocean, October 9, 1875. Notes the flights of this species, and believes it will never become habitually migratory.

1877. THOMAS, CYRUS.—Idem. 6th Rep. St. Ent. Ill., pp. 44, 45. Instance of its migration in Illinois. This probably not habitual.

1878. RILEY, C. V.—Idem. 1st Annual Report U. S. Ent. Com., pp. 443-448. Migratory habit, distribution, injuries. Modified form of migratory insects.

1880. THOMAS, CYRUS.—Idem. 9th Rep. St. Ent. Ill., pp. 127, 131-140. Description of imago; life history; injuries; remedial agencies.

1885. BRUNER, LAWRENCE.—Idem. Rep. Com. Agr. 1884, p. 399. Largely on the increase in western Iowa and eastern and central Nebraska.

1885. FORBES, S. A.—Idem. 14th Rep. St. Ent. Ill., p. 23. Injury to INDIAN CORN in Southern Illinois.

81. Acridium dmericanum, Drury.

1778. Drury, Drew.—*Gryllus americanus.* Ill. II., 128, fig. 1; pl. 4, fig. 2. Original description.

1865. Thomas, Cyrus.—*Acridium americanum.* Trans. Ill. St. Agr. Soc. V., 448, 452. Description of imago; distribution, and injuries.

1875. Thomas, Cyrus.—Idem. Rep. U. S. Geol. Surv. Terr. V., Part I., 172. (Synopsis of Acrididæ of North America.) Description of imago and distribution.

Riley, C. V.—Idem. 7th Rep. St. Ent. Mo., pp. 173, 174. Injuries to vegetation in Virginia.

1876. Riley, C. V.—Idem. 8th Rep. St. Ent. Mo., pp. 103, 104. Its occurrence with *Pezotettix spretus.*

1877. Riley, C. V.—Idem. 9th Rep. St. Ent. Mo., p. 84. Flights of this species reported from Ohio, Indiana, North Carolina, and Georgia.

Packard, A. S., Jr.—*Acrydium americanum.* 9th Rep. U. S. G. G. Surv. Terr., pp. 690. 691, pl. xliv, fig. 6. Occasionally very destructive to vegetation in Southern States, particularly to Indian corn and cotton.

1878. Riley, C. V.—*Acridium americanum.* 1st Annual Rep. U. S. Ent. Com. pp. 448–450. Migratory habits.

1880. Thomas, Cyrus.—Idem. 9th Rep. St. Ent. Ill., pp. 129–140. Description, life history, injuries, remedial agencies. Injury to Indian corn, p. 135.

Thomas, Cyrus.—Idem. Amer. Ent. III., 250. Sudden increase in southern Illinois, caused by dry weather.

1885. Forbes, S. A.—Idem. 14th Rep. St. Ent. Ill., p. 23. Injury to Indian corn in southern Illinois.

For further bibliography of the locusts of America, see 1st Ann. Rep. U. S. Ent. Com., 1877, Appendix xxvii, by B. Pickman Mann.

Class MYRIAPODA.

Family Iulidæ.

82. The Corn Myriapod.

(*Iulus impressus*, Say.)

1821. Say, Thomas.—*Julus impressus.* Proc. Acad. Nat. Sci. Phila., II., 102. Complete writings, II., 24. Original description.

1882. Coquillet, D. W.—Idem. 11th Rep. St. Ent. Ill., p. 44. Characters; condition necessary for its existence. Feeds upon the ears of Indian corn which lie upon the ground.

1884. Forbes, S. A.—*Iulus impressus.* 13th Rep. St. Ent. Ill., p. 140. Reported injury to stalks of currant bushes.

SYSTEMATIC LIST OF CORN INSECTS.

Hymenoptera.

1. Solenopsis fugax, Latr. (Small Yellow Ant).
2. Solenopsis molesta, Say.

Lepidoptera.

3. Arctia arge, Drury. (The Arge Tiger Moth).
4. Leucarctia acræa, Drury. (The Salt Marsh Moth).
5. Spilosoma virginica, Fab. (The Yellow Bear).
6. Empretia stimulea, Clemens. (Saddle Back Caterpillar).
7. Hyperchiria io, Fab. (The Io Moth).
8. Apatela oblinita, Sm. and Abb. (The Smeared Dagger).
9. Agrotis c-nigrum, Linn. (Spotted Cutworm).
10. Agrotis subgothica, Haw. (The Dingy Cutworm).
11. Agrotis herilis, Grote. (Western Striped Cutworm).
12. Agrotis clandestina, Harr. (W-marked Cutworm).
13. Agrotis messoria, Harr. (Dark-sided Cutworm.)
14. Agrotis tessellata, Harris. (Striped or Corn Cutworm).
15. Agrotis ypsilon, Rott. (Greasy or Black Cutworm).
16. Agrotis saucia, Hübn. (Variegated Cutworm).
17. Hadena devastator, Brace. (Glassy Cutworm).
18. Hadena arctica, Boisd. (The Yellow-headed Cutworm).
19. Laphygma frugiperda, Guen. (The Fall Army Worm).
20. Nephelodes violans, Guen. (The Bronze-colored Cutworm).
21. Gortyna nitela, Guen. (The Stalk Borer).
22. Achatodes zeæ, Haw. (The Spindle Worm).
23. Heliophila unipuncta, Haw. (The Army Worm).
24. Heliothis armiger, Hübn. (The Corn Worm).
25. Asopia farinalis, Linn. (Meal Snout Moth).
26. Pempelia lignosella, Zeller. (The Smaller Corn Stalk Borer).
27. Crambus zeëllus, Fernald. (The Root Web Worm).
28. Diatræa saccharalis, Fab. (The Corn Stalk Borer).
29. Lophoderus triferana, Walk. (The Red-banded Leaf Roller).
30. Dichelia sulphureana, Clemens. (The Sulphur Leaf Roller).

31. Sitotroga cerealella, Oliv. (Angoumis Grain Moth).
32. Tinea granella, Linn. (The Grain Moth).
33. Tinea zeæ, Fitch. (The Indian Meal Moth).

Diptera.

34. Sciara sp., ? (The Black-headed Grass Maggot).
35. Anthomyia zeæ, Riley. (The Seed-corn Maggot).
36. Diastata sp. ? (The Corn Leaf Miner).

Coleoptera.

37. Omophron labiatum, Fab.
38. Megilla maculata, DeG. (The Common Lady Bug).
39. Silvanus surinamensis, Linn.
40. Silvanus cassiæ, Reich.
41. Silvanus advena, Waltl.
42. Typhœa fumata, Linn.
43. Ips fasciatus, Oliv.
44. Tenebrioides dubia, Melsh.
45. Agriotes mancus, Say.
46. Melanotus communis, Gyll.
47. Melanotus cribulosus, Lec.
48. Sitodrepa panicea, Linn.
49. Aphodius lutulentus, Hald.
50. Macrodactylus subspinosus, Fab. (The Rose Beetle).
51. Lachnosterna sp. (The White Grub).
52. Euphoria inda, Linn. (The Indian Cetonia).
53. Prionus imbricornis, Linn. (The Tile-horned Prionus).
54. Diabrotica longicornis, Say. (The Corn Root Worm).
55. Systena blanda, Melsh. (Flea Beetle).
56. Chætocnema pulicaria, Melsh. (The Brassy Flea-Beetle).
57. Tenebrio obscurus, Fab.
58. Tenebrio molitor, Linn.
59. Epicauta vittata, Fab. (The Striped Blister Beetle).
60. Epicauta pennsylvanica, DeG. (Black Blister Beetle).
61. Epicærus imbricatus, Say. (The Imbricated Snout Beetle).
62. Sphenophorus pertinax, Oliv.
63. Sphenophorus robustus, Horn. (Corn Bill-Bug).
64. Sphenophorus cariosus, Oliv.
65. Sphenophorus sculptilis, Uhler. (Sculptured Corn Curculio).
66. Sphenophorus parvulus, Gyll.
67. Calandra oryzæ, Linn. (The Rice Weevil).
68. Calandra granaria, Linn. (The Grain Weevil).

Hemiptera.

69. Blissus leucopterus, Say. (Chinch Bug).
70. Jassus inimicus, Say.
71. Cicadula nigrifrons, Forbes.
72. Cicadula quadrilineatus, Forbes.
73. Macropsis nobilis.
74. Aphis maidis, Fitch. (Corn Plant Louse).

Orthoptera.

75. Anabrus simplex, Hald. (Western Cricket).
76. Orchelimum vulgare, Harr.
77. Pezotettix femur-rubrum, DeG. (Red-legged Locust).
78. Pezotettix atlanis, Riley. (Lesser Locust).
79. Pezotettix spretus, Thos. (Rocky Mountain Locust).
80. Pezotettix differentialis, Thos.
81 Acridium americanum, Drury.

Class Myriapoda.

82. Iulus impressus, Say.

NOTES FROM LIVINGSTON AND ADJACENT COUNTIES.

Dr. F. W. Goding, of Ancona, Livingston county, acted during the season as a local observer for the office, and from his notes and letters the following data are gleaned:

May 16, WIREWORMS were found in great numbers in recently planted corn, eating the root sprouts of the kernels; in no case attacking the young plant. They were found in about fifteen per cent. of the hills examined, in some cases so affecting the corn as to necessitate replanting. The injury continued for about two weeks, during which the weather remained dry and clear, but complaints ceased with the appearance of the first rains.

GRASSHOPPERS were first noticed in abundance, feeding upon corn, on the 29th of June, at which time they were still in their larval stage. "July 23, I called at Mr. D. Rice's where the insects were to be seen by the millions,—in the pupa stage, usually."

"There were several species, the greater number being *Pezotettix femur-rubrum*, *P. atlanis* and *P. bivittatus*, mature. In the field we examined them carefully. As the mower, in its work, gradually decreased the area of standing grass, the insects accumulated in such numbers that the field was blackened, while the grass was crushed to the earth. Millions upon millions were to be found. The hay-cocks were covered so closely that the forks in the hands of the laborers inevitably speared many. The air above and around was literally alive with the grasshoppers, causing a premature twilight to appear. The barns were so thoroughly covered that the color of the paint could not be distinguished.

"The greatest damage, however, was to the oat crop. The insects were found in the usual countless myriads engaged in destroying the grain. They would gnaw off the stalk just below the head, which dropped to the ground and was lost. I passed by several fields the edges of which had been ruined,—rarely a head of grain to be seen for a distance of several rods from where I stood. This was continued, in many fields, over the entire surface—in such instances the crop of course being a total failure. Many fields of grain harvested which, had it not been for the ravages of the pest, would have yielded at least fifty bushels per acre, gave only from three to sixteen bushels per acre. In every case the entire field was damaged more or less, but always to a greater degree around the edges.

"From August 15 to Sept. 1 I was in Kane county, where I learned of the damage to oats and corn by the locusts. Oats were damaged from three to thirty bushels per acre. One farmer had previously estimated his oat crop at forty-five bushels per acre; he realized

three bushels. Others estimated their loss at from three to fifteen bushels per acre. I examined corn fields in the vicinity of Blackberry (Kane county) that had been damaged by locusts. The insects would gnaw off the end of the ear (cob, kernel, and husk with silk) with as great a degree of nicety as could be attained with a sharp knife. The kernels would then be eaten for quite a distance towards the butt of the ear, beneath the husks. The damage was estimated by farmers at about fifteen bushels per acre—rather high, I think.

"In Livingston county the locusts appeared in injurious numbers in a strip averaging five miles in width. On either side of the borders the locusts were not heard from."

The CHINCH BUG was extremely rare in his vicinity, not coming to his notice until August 3, when a number were found in the larval stage.

The GRAPE BERRY MOTH (*Eudemis botrana*, Schiff.) has been very destructive to grapes in Livingston county for the past two years.

A *dipterous larva* was noticed injuring celery, both last year and the preceding, in both Livingston and Kane counties. It begins to gnaw the base of the stalk, gradually progressing upwards. Its presence is easily traced by worm-eaten passages, which early turn to a rusty color. The maggot is about three fourths of an inch long, footless, dirty pale yellow, posterior extremity truncate, the head with the usual two black hooks of dipterous larvæ. It pupates within the celery stalk, emerging as an imago early in June. "The single fly I obtained may be described as follows: The general color is black, sprinkled with yellow hairs, the head being dark brown. The wings are clear, with veins light yellow, as also are the legs. The body is about 7 mm."

The following notes on the prevalence of the CABBAGE WORM will be of interest as related to the effect of *flacherie:*

"While in Kane county, I found the cabbage plants to be almost totally destroyed so far as heading was concerned. *Pieris rapæ* was everywhere numerous. The heading process having been prevented, the plants grew rapidly upwards to a considerable hight, putting out long, slender leaves, and presenting a very peculiar appearance. These leaves were infested by the cabbage aphis. The crop in Blackberry and Kaneville townships was a failure. This was in striking contrast with the cabbage patches of Reading township (my own home). Here, in the previous years, the *Pieris rapæ* had almost entirely prevented the rearing of a sound cabbage head, while during the past year I failed to obtain a single specimen of the larva, though occasionally an imago would be seen flitting by. Their absence was due chiefly, I think, to the parasitic disease which destroyed so many two years ago. Around Streator, where large fields of cabbage may be seen every year, the pest was far less troublesome than in former years. While on the subject of *P. rapæ*, I will remark that I repeated the experiment, several times this summer, of preventing oviposition of the female by applying kerosene emulsion freely on the plants during the time the butterflies were about."

THE RASPBERRY MEASURING WORM, *Eutrapela transversata*, Drury, was sufficiently numerous near Ancona, during the summer of 1884,

to injure seriously the raspberry crop. "It is mentioned by Dr. Packard as having been found by him on red maple leaves, and he also mentions the sweet pepper bush (*Clethra alnifolia*) as its food plant, while Mr. Emerton observed it on the currant. [Prof. French has observed it near Carbondale feeding on *Lepidium virginicum* and *Polygonum aviculare*.] As this species is not mentioned in any of the numerous entomological reports or works on applied entomology [excepting by French], it has probably not heretofore been injurious. The larva injures the crop by eating the leaves and berries, and the same articles of diet were taken by all the specimens reared by me. I first noticed them during the middle of June, at which time they were about half grown. Those reared in confinement made the cocoons July 5th to 7th, the larvæ changing to chrysalids two days later.

"The larva is of a beautiful reddish violet color, marked transversely with reddish stripes, and 2½ to 3 inches long. On the third thoracic ring is a sharp tubercle, while just behind the middle of the body is a large wart, and also one on each side of the middle; just in front of the last pair of abdominal feet, on the back, is quite a large hump. The larva is a handsome object, and when once seen and identified, is easily recognized afterwards. The cocoons were made of raspberry leaves and berries, in nearly circular arrangement, the whole mass held together with silk. The cocoons were all formed on the floor of the breeding cages. In one instance the larva crawled into a cocoon that had been made by another species, and in due time emerged as a moth. The pupa is three fourths of aninch long, flesh-colored except the end of the abdomen, which is reddish brown. On the back is a row of black dots, one for each ring, and on the side are three rows, one continuing to the head. The whole is sprinkled with reddish dots. The venation of the wings and the antennæ were plainly to be seen.

"The moths appeared July 24 and 25. They were quite variable in color and markings, yet there was a close general resemblance. Usually of a fawn color, some were light ochreous and others dark reddish brown. On the fore wings were usually found two chocolate brown lines, the outer one making an acute angle near the apex, and as a rule passing over the surface of the hind wings also, while the inner line was more wavy and rarely passed on to the posterior wings. Outside of the outer line were several darker shades, which, in many specimens, were brown patches. Near the center of each wing the discal dot was always present.

"When the matter of remedies is to be considered, one is to be sought for that will not only destroy the pest, but also leave the fruit in an edible condition. The kerosene emulsion and arsenical preparations were tried and found effectual for the destruction of the insect, but when applied while the fruit was yet on the plants they of course rendered it unfit for use. When for any reason the fruit is not to be gathered, or when the caterpillars appear after the fruit has been harvested, the above preparations may be used with benefit. The remedy found most useful was hand-picking or beating the bushes with large broom-corn brushes, and then crushing the larvæ as they fall to the earth. As yet the time and place of

oviposition are not known, and it may be that they are most vulnerable in the egg state. If so the kerosene emulsion will be effective if the eggs are in exposed location.

"Last winter and this spring the small plain brown beetle known as *Stenosphenus notatus*, Oliv., was present in immense numbers, seriously injuring and destroying vast numbers of hickory trees in the woods about here. Unless preyed upon by many parasites it will soon exterminate our hickory trees."

FIFTEENTH REPORT

OF THE

STATE ENTOMOLOGIST

ON THE

NOXIOUS AND BENEFICIAL INSECTS

OF THE

STATE OF ILLINOIS.

FOURTH REPORT OF S. A. FORBES,

FOR THE YEARS 1885 AND 1886.

SPRINGFIELD, ILL.:
SPRINGFIELD PRINTING CO., STATE PRINTERS.
1889.

NOTE.—In the absence of a formal report for 1885, I prepared and published for that year, as an appendix to the Transactions of the State Department of Agriculture, a collection of essays on economic entomology, containing the greater part of the matter which would have gone regularly into an annual entomological report, and the papers of the present report are, therefore, substantially those prepared for the year 1886. The long delay in the publication of this report (now just going to press) has led me to withdraw several articles on subjects which more recent observations and experiments will enable me to treat to better advantage hereafter. The most important of these are one on the root web worm and one introductory to a monograph on the insects injurious to Indian corn.

S. A. FORBES.

JUNE 20, 1889.

LETTER OF TRANSMITTAL.

OFFICE OF STATE ENTOMOLOGIST,
CHAMPAIGN, ILLINOIS, December 30, 1886.

To His Excellency, RICHARD J. OGLESBY, *Governor of the State of Illinois.*

SIR: I have the honor to transmit herewith my report as State Entomologist for the two years ending December 31, 1886. As a recent opinion of the Attorney General makes it doubtful whether I have a right, under the laws relating to this office (to some extent inconsistent and conflicting) to prepare any other than a biennial report, I made no formal report for 1885, and shall hereafter make biennial reports only, supplementing these by bulletins of the office, issued whenever important results of new work or entomological occurrences of special interest to the general public make it desirable that prompt information should be given.

I am further induced to this course by the fact that thus only can I continue to provide both for the work of the entomological office and for that of the State Natural History Survey, for which, as Director of the State Laboratory of Natural History, I was made responsible by the Thirty-fourth General Assembly.

Respectfully submitted,

S. A. FORBES,
State Entomologist.

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THE ENTOMOLOGICAL RECORD FOR 1885-86.

To the economic entomologist the season of 1885 was especially notable for an extraordinary outbreak, in the western part of the State, of two or three of our common species of grasshoppers; and 1886 was distinguished by a disastrous attack of the chinch bug on the wheat, oats, and corn of Southern Illinois, which, together with a severe drouth, greatly diminished the crops of small grain and hay over several counties, and completely destroyed the corn in hundreds of fields. The grasshopper uprising having now disappeared, a full account of it is given elsewhere; but a discussion of the chinch-bug attack may best be postponed until another report, when its complete history may probably be written.

THE EUROPEAN CABBAGE WORM (*Pieris rapæ*) has clearly been less abundant during the past two years throughout that part of the State under our observation than for several years preceding. The same scarcity was noted by some of my correspondents. Dr. Goding, for example, writing from Livingston county on the 24th July, 1885, reported that it was difficult to find a single cabbage worm in the field; and Dr. Boardman, in August, 1885, informed me that these insects were very much less abundant in Stark county than usual. This difference, so favorable to the horticulturist, was due apparently to the continued prevalence of the white plague of the cabbage worm,—a destructive disease first reported by me in September, 1883, and described in full in the Bulletin of the Illinois State Laboratory of Natural History, Vol. II., Art. IV., pp. 261–264. Numerous examples of its extraordinary destructiveness occurred in the course of our observations. Visiting a cabbage field near Champaign late in August, 1885, the owner of which had reported a few days previously that it was being destroyed by the cabbage worm, we failed to find in twenty minutes' search a single living larva, the leaves being, however, badly riddled, and the dried and blackened remnants of the dead cabbage worms giving unmistakable evidence of their recent presence.

From Dr. Lintner, State Entomologist of New York, I learned that this malady had appeared in that State, information to the same effect coming also from Mr. Goff, of the New York Agricultural Experiment Station. In a subsequent letter, the latter gentleman contributed the interesting information that Prof. Arthur, the botanist of the station, had experimented with reference to the contagious character of the disease by feeding portions of the bodies of larvæ recently dead to still living and healthy worms, the effect being the speedy sickness and death of those thus treated. From William Saunders, Esq., of Ontario, Canada, I learned October 5, 1885, that there seemed to be no traces of the disease among the cabbage worms of his vicinity. Prof. Snow, of Topeka, Kansas, likewise informed me in 1885 that it certainly had not appeared in his vicinity; but in August, 1886, I received from correspondents in Kansas, specimens apparently suffering from a mild form of this affection. Mr. E. W. Doran, of Loudon, Tennessee, Assistant Entomologist to the Board of Agriculture of that State, reported to me both in 1885 and in 1886 that he was unable to detect any evidence of its occurrence there.

In the southern part of the State the SOLITARY CATERPILLAR (*Callimorpha lecontei*) has lately become excessively numerous, and because of the early period of its activity has been found capable of great injury to raspberry plants. The caterpillars climb the stems, gnaw the swelling buds, and eat the young leaves as fast as they put forth. Spraying with arsenic has proved ineffective, because the rapidly unfolding leaves afford an abundance of fresh food soon after the application of the poison. Hand picking has given the only satisfactory protection.

In the course of a series of experiments performed upon the CODLING MOTH (*Carpocapsa pomonella*), this species has received at our hands extraordinary attention in all its relations. An elaborate account of our observations respecting its life history and its susceptibility to remedial measures is given in another article: and I add here only facts showing the abundance of the species during the two successive years. Of nearly 10,000 apples examined from trees used as checks upon our experiments in 1885, and which, consequently, had not been treated with any insecticide, fifty-nine per cent. had been infested by the codling moth—a proportion doubtless unusually great, and due in part to the extraordinary scarcity of apples following a year of great abundance. In 1886, on the other hand, when the apple crop was an abundant one, following the scanty crop of the year before, a similar examination of 5,000 apples showed that only thirty-nine per cent. were infested.

That dread enemy of the cereal crops, the notorious ARMY WORM (*Heliophila unipuncta*), occurred in injurious numbers in 1885 throughout Southern Illinois, from Bond and Wabash counties to

Alexander and Gallatin, and was occasionally reported in June to have made a visible impression upon the crop of corn. In 1886, however, no reports of injuries by this pest were received, although an extremely dry season throughout this region would seem to have favored its multiplication. None of the "armies" of the previous year came then under our observation, and the precise reason for the scarcity of the species this year is unknown.

Various apple leaf insects have interposed a serious obstacle to successful nursery culture, almost completely obstructing, in some localities, the business of growing young apple-trees for the market. At Normal, especially, in the grounds of the Home Nursery Company, the mischief worked on the susceptible varieties has been of a very discouraging character, and has even disposed the proprietors to transfer their apple business to a western state.

As a result of a short series of experiments made with kerosene emulsion and with lime, I learned that no liquid or powdery application could reach a sufficient number of the larvæ, secluded in the rolled and webbed leaves, to make it at all worth using for its immediate effects; but a series of field and laboratory experiments made in 1886 has given us the means of controlling these nursery pests at slight expense,—as detailed in an article on nursery insects in another part of this report.

The HESSIAN FLY (*Cecidomyia destructor*) was locally injurious in 1885 in the counties of Fayette, Effingham, Clay, Lawrence, and Alexander, a few fields being left unharvested because of it in the three first mentioned. A careful canvas of the southern part of the State made in May and again late in June, failed to discover any damage except to one field each in Effingham and Lawrence counties. Its isolated occurrence in these localities gave an excellent opportunity to determine by experiment and observation some points of interest in its midsummer life history. The results of our investigations, with suggestions of preventive and remedial procedure based upon them, are deemed of sufficient importance for especial discussion in a separate article.

The CLOVER SEED MIDGE (*Cecidomyia leguminicola*), first described by Lintner as *Cecidomyia trifolii*, in 1879, (the present name being afterwards substituted for the above,) was first reported in Illinois, as far as I can learn, by W. F. Carpenter, of Steward, Lee county, in 1882, in a note to the "Prairie Farmer," the date of which I have not at hand; but in a recent letter Mr. Carpenter informs me that he first observed the pest in Illinois in 1878 or 1879. As it was first observed by Lintner in New York in 1877, it is difficult to say whether this was originally an eastern or western species, or whether it may not have secretly pursued a less offensive course for some years in various parts of the country. In Northern Illinois it was especially injurious in 1886, notice of its ravages coming to the office from the Farmers' Club of Marengo, in October.

From some infested clover heads obtained through the secretary of the Club, N. J. Wheeler, we had the good fortune to breed five specimens of a new parasitic enemy of this midge,—a chalcid belonging to the genus Tetrastichus, and apparently of a species undescribed. Previous to this, two species of parasites have been reported as preying on it,—*Eurytoma funebris*, Haw., and *Platygaster error*, Fitch. Additional insect enemies were detected in our breeding cages,—one of them a small heteropter (*Triphleps insidiosus*), so abundant everywhere that it may well serve a useful purpose in lessening the numbers of this clover pest.

The interesting discovery was made this summer (1886) that an additional brood (making three in all) of the WHEAT BULB WORM (*Meromyza americana*) may develop in midsummer in self-sown wheat.

A very peculiar larva (*Cardiophorus*) of the family to which the common wireworms belong, was found in June perforating and mining the roots of corn in the sandy soil of the "second bottom" in Alexander county, the corn as a result being not more than half the size of that in adjacent fields.

The very common BLISTER BEETLES (*Meloidæ*) were far more abundant in 1885 than usual,—a fact doubtless to be connected with the extraordinary abundance of grasshoppers, upon the eggs of which their larvæ are well known to feed. The species most frequently mentioned in our notes of injuries to crops are the striped blister beetle (*Epicauta vittata*), the margined blister beetle (*E. cinerea*), and the common black blister beetle (*E. pennsylvanica*). The last is yearly abundant, feeding in autumn upon the flowers of the golden rod and other composite plants; but the other two species are more variable in their numbers. The abundance of *E. pennsylvanica* was noticed as early as the 4th of July, at which time we found it feeding upon the leaves of the honey locust. In August it was very common in corn fields, associated with the two other species, all of which were feeding freely upon the fresh silk of corn, doing thus, apparently, a very considerable mischief by preventing the fertilization of the kernels, and partially blighting the ear. Rarely, also, we saw the black species eating the kernels at the tip of the ear. The striped blister beetle, likewise common in corn, was still commoner upon potatoes and tomatoes, often stripping these plants of their leaves. The margined blister beetle was also noticed in July and August feeding upon potatoes and tomatoes, sometimes more abundant than the striped species. In corn fields it attacks an allied weed, the common ground cherry (*Physalis viscosa*).

THE CORN ROOT WORM (*Diabrotica longicornis*) seems certainly no less abundant than hitherto, although farmers who have adopted the practice of frequent rotation are rarely subject to its injuries. Heretofore it has not been noticed in corn fields south of the central region of the State; but I this year detected the larva

of this or some closely allied species, in June, in a corn field in Alexander county in numbers sufficient to arrest the growth of the corn in irregular patches, here and there. I feel bound to do my best to excite the serious apprehension of farmers respecting the future of the corn root worm in regions where it is being neglected. I have no doubt that under such circumstances, multiplying continuously, as it is liable to do. it will in time accumulate in such numbers as no longer to confine its chief injuries to fields principally in corn, but that the beetles will be early forced to scatter in search of food, from the fields in which they emerged, and that the eggs will consequently be freely laid everywhere in the ground instead of being confined, as now, chiefly to fields of corn. Indeed, there is already some serious indication of the approach of this calamity. From Mr. R. C. Davis, of French Grove, in Peoria county, I learned that the adult beetle had been seen in his vicinity, flying in swarms so early in the season that it is not at all likely that the females had yet deposited the principal part of their eggs. In such cases, the ground will almost certainly be heavily stocked with the eggs wherever a sufficient food supply occurs, and fields not lately in corn will be liable to show next year evidences of serious injury by. this pest. As the beetle lives largely upon the pollen of plants, and congregates upon clover heads and other late blooming flowers, it is in fields of clover or those containing an unusual amount of fresh young vegetation that this prevalence of the corn root worm is likely to be noticed.

It is not unlikely that the abundance of grasshoppers in corn fields in some parts of the State, and the consequent diminution of the ordinary food supply of the corn root worm beetle, may have forced it to leave the corn fields earlier than is its custom. But this consideration serves to enforce the importance of a general rotation of crops as a safeguard against a pest so liable to take advantage of even slightly favoring circumstances and to inflict uncontrollable damage upon the principal farm crop of the State.

As a very effective precaution against a possible injury to corn by the root worm, on ground not last in corn, I would suggest the early plowing of such fields. By thus destroying the food of the adult before the season for the laying of the eggs, all temptation to resort to these fields will be removed. To this end, ground in clover, or that covered with any sort of late blooming vegetation, or with a fresh growth of tender herbage, like volunteer oats, should be plowed before the middle of October if intended for corn.

Old meadows near Edgewood, in Effingham county, were found in July, 1886, noticeably damaged by the larva of *Sphenophorus parvulus*. Another insect of the same family (*Ithycerus noreboracensis*) was sent me from Bureau county, with a report of its characteristic injury to the leaf buds of the apple.

Injuries to the most important crop of the State by its most threatening insect enemy (the CORN PLANT LOUSE, *Aphis maidis*)

seem to me to be decidedly on the increase. Hitherto, our studies of its life history have given us no hint of a method of control; but observations made during the spring of 1886 make it seem possible that this destructive species may be added to the list of those capable of being held in check by the ordinary processes of an intelligent agriculture. The early period at which the presence of this insect may be detected in fields of the most various history, has seemed to justify the inference that its occurrence has no close relation to the rotation practiced; but a long series of careful observations made *very early*, when the corn was but an inch or two high, failed to discover a single instance, out of a great number, in which this louse was present in fields where the ground had not been in corn the year preceding. It was seen, however, that the development of a winged generation may occur so soon as to give opportunity for very early infection of corn on stubble or sod.*

The notorious SOFT MAPLE BARK LOUSE (*Pulvinaria innumerabilis*), which so seriously injured soft maple trees in 1884, seemed to the casual observer, in spring of the following year, to threaten an equal injury; but upon close inspection late in June, the cottony egg masses of the female were found, in nearly every instance examined, to harbor a coccinellid larva (*Hyperaspis*) by which the eggs were being rapidly devoured; and before the end of the season the pest was reduced to insignificance throughout the greater part of the area infested by it.

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* Since the above was written, the winter history of this species has been determined, chiefly by investigations made, under my direction, by my assistant, Mr. C. M Weed. The eggs are collected from the ground in autumn by the common brown ant, *Lasius alienus* Early in in spring, before corn is planted, the young lice, as they hatch, are placed on the roots of "pigeon grass" (*Setaria*), smartweed (*Polygonum*), and possibly some other weeds, and are reared there until the field is planted to corn—if this is done,—when they attack the corn roots or the subterranean part of the stem. If the field is planted to some other crop, the young lice mature on the grass roots and produce a second brood, many of which acquire wings about the middle of May, and then disperse. Later, they seem to abandon the grasses entirely.

ARSENICAL POISONS FOR THE CODLING MOTH.

(*Carpocapsa pomonella*, L.)

Order LEPIDOPTERA. Family TORTRICIDÆ.

I published last year (1885), in the Report of the State Department of Agriculture* and in the Transactions of the State Horticultural Society,† a report on some preliminary experiments made with two arsenical poisons and with lime, for the codling moth and the curculios, the general result of these experiments going to show that about two thirds of the apples subject to loss through the codling moth, and one half of those liable to be destroyed by the curculios, might be saved by spraying eight times with Paris green. Last year was, however, an exceptional year, the apple crop being very unusually light, following a good crop of the year before. Moreover, eight times' spraying was clearly an excessive use of the poison, the arsenical compounds being presumably ineffective against the second brood of the codling moth, and certainly dangerous to health, if not to life, if used on the apple after midsummer. Our work of last season was consequently inconclusive with respect to some important points; and I made this summer (1886) similar experiments on a larger scale, intended to complete and test the evidence of the year before, to try arsenic in solution in comparison with London purple and Paris green, and especially to test carefully and thoroughly the effect of a moderate number of sprayings with poisonous insecticides applied only so early in the season that there could be no possible question of danger to the consumer of the fruit. I used this year Paris green and a solution of arsenic in comparison on eight selected trees. Two of these were sprayed with a solution of white arsenic and six with Paris green in water—two of the six sprayed once, May 11; two twice, May 11 and 24; and two three times—the last, June 6. Companion trees were selected as checks upon each of those thus treated, the check trees being, of course, left unpoisoned.

The Paris green mixture was the same as last year, three fourths of an ounce by weight, of a strength to contain 15.4 per cent. of metallic arsenic, being simply stirred up in two and a

*Appendix, pp. 26–45.
†Vol. XIX, pp. 108—124.

half gallons of water. The arsenic solution was made by boiling one ounce of arsenic in one quart of water, and adding this solution to twenty gallons of cold water. The method of procedure was precisely as last year, the trees being thoroughly sprayed with a hand force-pump, and with the Deflector Spray and Solid Jet-Hose Nozzle manufactured by the Lowell Faucet Company, Lowell, Massachusetts. The fluids were thrown in a fine mist-like spray, applied until the leaves began to drip.

The character of the season was the precise opposite of that of the year preceding. Then a scant crop followed an abundant one; now an extraordinarily abundant crop followed a very scanty one. The ratio of insects to the apples exposed to their attacks must have been, consequently, doubly diminished as compared with that of 1885. Further, our experiments were last year limited to early apples, no late fruit being available; while this year only fall and winter varieties were used. In these, finally, an additional brood of the codling moth probably developed, making three in all for the season; while last year we certainly had but two up to the time of harvesting our experimental fruit.

After spraying, the apples which fell, both from the poisoned trees and the untreated checks, were regularly picked up at intervals of about two weeks, until October 4. These lots were each examined for codling-moth injuries, as were also the picked apples gathered from the trees October 4. The entire number of apples examined from all the trees was 38,688.

From the data thus recorded tables were prepared, such as I published in my last year's report; and upon these tables the present discussion is based. As this year's experiments are really continuous with those of the year preceding, I have brought my last year's results into this discussion, preferring to present the whole subject in a complete and finished form, even at the expense of some slight repetition of matter already published.

I have made principal use of the figures in the column marked "Corrected"—a matter requiring a somewhat elaborate explanation. Ratios are comparable, of course, only when reckoned on the same base. For the check trees, the ratios of damage to the fallen apples were calculated on the total number fallen, and for the picked apples the basis of the reckoning was the number remaining on the trees at the end of the season. Since the treatment of the experimental trees kept from falling a certain number of the apples which would otherwise have fallen, it is evident that ratios computed on the fallen and picked apples from these trees are not comparable, without correction, with those obtained from the checks. The number of fallen apples being relatively smaller, the ratios of injury calculated on that number will be too large; while with the picked apples the case will be reversed. The ratios were consequently corrected throughout by the application of formulæ printed in our Bulletin 1, but which it is not necessary to repeat here.

Paris Green, 1885.*

We begin the discussion with Table I., exhibiting the result of the spraying of two trees eight times with Paris Green in 1885 as compared with two other trees selected as checks,—the former bearing 2,419 apples, and the latter 2,964. After spraying three times (June 9, 20, and 30), the apples were first picked up July 16; and already fifty-nine per cent. of those fallen from the check trees were wormy. Passing down the "ratio" column of the check tree, we see at first a slight rise in the ratio of injury, and then a falling off to fifty-eight per cent., July 31, and fifty-five per cent. August 7—the lowest point of the season. This decline coincides with the interval between the first and second broods of the larvæ.

Our notes of July 31 show that at this date no full grown larvæ whatever were found, and only a few very small ones, at the blossom end of the apple—evidently the young of the second brood.

The averages of injuries to fallen fruit now increased rapidly to September 3, when the last observation was made. At this date the injury to fallen apples reached eighty-four per cent. The total for all the fallen apples of the season was sixty-five per cent., and that for the picked apples was seventy-five per cent. Finally, adding fallen and harvested apples in one grand total, which includes the entire product of the trees, we conclude that sixty-eight per cent. had been infested by this insect.

These data give us our standard of comparison. Looking now at the columns relating to the poisoned trees, we notice that these suffered much less from the codling moth than the others. Beginning at about three per cent., the injury rises to thirteen per cent., falls again to six per cent., and does not rise thereafter above eleven per cent. (August 7). The average injury for the season to the fallen fruit is nine per cent., and to the picked fruit 31 per cent.; or, to all the apples taken together, twenty-one per cent. Generalizing, we may say that eighty-six per cent. of the apples which would have fallen from codling-moth injuries have been preserved from falling, and that fifty-nine per cent. of the picked apples which would have become wormy remained uninjured; or, taking all the apples from these trees together and comparing with the entire crop of the check trees—assuming, as we evidently have a right to do, that as large a proportion of the fruit on the experimental trees would have been destroyed as on the check trees if the former had not been sprayed,—we shall find that of the apples thus exposed to damage by the codling moth, almost exactly seventy per cent. have been saved by our treatment.

Comparison of injuries, 1885 and 1886.

Before passing to the discussion of the experiments of the present season it will be necessary to compare the consequences of

*Some slight discrepancies between these discussions and those of Bulletin 1 of the office are due to the fact that these are drawn from the tables, and those from the diagrams there published.

the difference in the prevailing conditions of this year and those of last, as affecting the codling-moth injuries in the orchard. I have already given a general account of the differences between the two years; and the manner in which these influenced the codling moth is exhibited in Table II., comparing the ratios of injury in 1885 to four untreated trees bearing 6,825 apples in all, with that to 4,916 apples on four untreated trees, in 1886. As the experiments for 1885 related only to summer apples, and those for 1886 to fall and winter varieties, there are two more observations (for September 20 and October 4) reported on the latter than on the former.

We notice in the first place the smaller ratio of injury for 1886 at the beginning of the season. The difference between the two sets of trees, beginning July 16 at forty-six per cent. out of fifty-one, diminishes rapidly to August 31, when it was twenty-five per cent. out of eighty, and closes September 8 at thirty-eight per cent. out of eighty-five. The total damage by codling moths this year was seventy per cent. that of last year to fallen fruit, and fifty-nine per cent. to picked fruit. This difference is due to the fact that the crop of 1886 was very heavy, the trees setting full in the spring and dropping a large percentage of merely surplus fruit during the first four weeks; while the crop of 1885 was very light, and the trees were able to hold more of their apples.

PARIS GREEN, 1886.

The experiments for 1886 to be first noticed, were intended to bring out the comparative results of spraying once, twice, and thrice with Paris green so early in the season as to avoid any possible danger from the poisoning of the ripened fruit. Two sets of experiments were made for this purpose. In the first, trees of the same variety (the Snow apple, or *Fameuse*) were used both for the experiment and for the check; while in the second series various varieties were treated, care being taken, however, to select the best available companion for each experimental tree.

We will first examine the *Fameuse* series, since this was much the most uniform. It will be seen from Table III. that the single spraying (made May 11) had a very appreciable effect upon the damage by the codling moth even in the beginning of the season, but was still more evident later. Without entering into unnecessary details, it will be sufficient to say that the results show a preservation to ripening, of fifty-five per cent. of the fruit subject to fall from codling-moth injuries. It will be seen also that there was a corresponding benefit evident in the condition of the picked fruit, the damage on the tree not treated being forty-five per cent. and that upon the sprayed tree twenty-two per cent. The exceedingly low ratios of injury at the beginning of the season—a phenomenon which will be apparent throughout all the

tables for this year—have, of course, the explanation already given; viz., that the trees set very full in spring and early cast a great quantity of their surplus apples.

A curious drop in the ratios of injury of both check and experimental trees for the observation of September 8, probably marks an interval between second and third broods similar to that already noticed between the first and second of last year.* The same indication is apparent on Tables IV., VI., and IX.

Of the apples borne by these trees, we examined 2,060 from the check, and 1,580 from the tree sprayed with poison. The number on these and several other of the trees was so great that towards the end of the season we did not handle them all, but stopped when we had demonstrated that we had a fair average of the whole.

The increased benefit from a second spraying is made evident by a comparison of Table IV. with the preceding one. Although the ratio of benefit to fallen fruit is somewhat less, the fifty-one per cent. benefit to the picked apples once sprayed (Table III.) becomes eighty-four per cent. after the second spraying (Table IV.). Curiously, the third spraying (Table V.) seems to have been without important effect, the benefit to fallen fruit being a little greater and that to picked fruit a little less on this table than on the preceding. The record from two other trees not tabulated here, gives a similar result.

The respective advantages of spraying once and twice are more fully represented on Table VI. The benefit from the second spraying begins to be conspicuous August 31, and continues quite to the end of the season, October 4. The total effect on the fallen fruit is apparently slight; but this is due to the fact that much the larger part of the apples fell from general causes early in the season. The ratios relating to the picked fruit are not disturbed by this superabundance of early windfalls, and more correctly exhibit the relative effects of spraying once and twice. By this the damage to picked fruit after twice spraying was only about one seventh that after spraying but once.

The most remarkable exhibition of benefit is that of Table VII., where a single tree twice sprayed—the Vandevere variety—is compared with its selected check. The damage to the latter ranges, as will be seen, from naught to sixty-two per cent., the general average for the fallen fruit being forty-eight per cent. and for the picked apples forty-three per cent.; while that to the treated tree varies only from zero to six per cent., the "total fallen" being

*On the 31st August the larvæ were reported by the assistants engaged on the work as "mostly full grown," and September 8, as mostly full grown, but with specimens occasionally occurring that were not more than half size. September 20, on the other hand, when 4,146 apples were examined, a very large percentage (three fourths to five sixths) of the apples contained very small larvæ, many of them near the blossom end and apparently just entering, the others being all full grown. October 4, finally, many of the apples contained very young larvæ, although the majority were one third to two thirds grown. The notes of the assistants are supported by alcoholic specimens.

four per cent. and the "picked apples" two per cent. Or, stated in another form, the ratio of benefit shown by the picked fruit was ninety-five per cent., while ninety-two per cent. of the apples liable to fall from codling-moth injuries were preserved to ripening by the Paris green.

This tree was low and broad and not too leafy, and was thus more thoroughly sprayed from the ground than the other experimental trees. There is also a possible lack of proper correspondence between the tree and its check to be taken into account in connection with this remarkable and exceptional result.

SUMMARY OF PARIS GREEN EXPERIMENTS.

As a summary statement of the final issues of the Paris green experiments for both years, we may refer to Table VIII., where it will be seen, in brief, that in 1885 eighty-six per cent. of the fruit exposed to damage by the codling moth was preserved to ripening by the poisons applied, and that fifty-nine per cent of the picked fruit had been thus preserved; or that, taking picked and fallen fruit together, sixty-nine per cent., which would otherwise have been sacrificed, had been saved by our remedial measure.

Furthermore, during 1886 seventy-four per cent. was saved from falling, by a single spraying, and about seventy-two per cent. by three sprayings. The difference unfavorable to the last was doubtless due to accidental differences in trees and treatment.

The benefit to the picked fruit apparent from a single spraying stands at forty-eight per cent., and that from twice spraying at ninety per cent., while that from thrice spraying falls away to seventy-nine per cent. Or, summarizing still more briefly, we may say, in general, that *the results of once or twice spraying with Paris green in early spring, before the young apples had drooped upon their stems, resulted in a saving of about seventy-five per cent. of the apples exposed to injury by the codling moth.*

I wish especially to emphasize the fact that the results now obtained are drawn from computations so made that they may be expected to hold good without reference to conditions other than variations in the treatment itself. The apples protected from injury by the codling moth are evidently apples *effectively poisoned;* and our "ratios of benefit" really express the ratios of these poisoned apples to the whole number treated. These ratios clearly will not vary either with the abundance of the apples, with the abundance of the codling moths, or with anything else except the original treatment, and subsequent accidents affecting the *length of time* the poison may adhere to the apple. This view is, in fact, substantiated by the essential agreement between the results of last year and this, under conditions as widely different as it would be possible to find by ten years' waiting.

The weather conditions prevailing shortly after the poison is applied will doubtless have much to do with its efficacy; but pos-

sible variations of this sort are so numerous, and a precise examination of their effects upon the remedy would require such an interminable series of laborious and costly experiments, that I have thought it best to leave this subject to the practical fruit grower, for determination on the larger scale of orchard practice.

It is also especially to be noted that the final summaries of injury are much greater in our experiments than they would have been if all the trees in the orchard had been treated, as in the practical application of this method in the field. Since we purposely left as many trees untouched as we sprayed, and since in our experiments of this year the trees under observation were surrounded by other trees heavily laden with apples, to which we gave no attention, there were necessarily bred in these trees an abundance of codling moths of the first brood, which, spreading to our experimental trees, must have greatly increased the ratio of injury by the later broods.

In orchard use, however, where all the trees would be poisoned, the later broods could represent only the small percentage of the last generation which had escaped the treatment.

TIME OF APPLICATION.

We have next to determine the time of the year at which poisoning is the most effective; whether, in fact, it takes principal effect upon the first brood or the later ones. A moment's reflection will show that if only the first brood of the larvæ was directly diminished in a certain ratio, the second brood should show a similarly diminished ratio, since these descend from the first; whereas if both first and second broods are directly poisoned, then the ratio of damage to the second brood should be greater than that to the first; or, in other words, the percentage of benefit to the picked apples should be greater than that to the fallen. Our data for the present season do not apply to this question, since all the sprayings were made in May and early in June, while the apples were still very small; and it is incredible that the poison should have remained upon the fruit through all the vicissitudes of weather and time for the two months and more that elapsed before the appearance of the second brood of larvæ. The results of last year, however, when the spraying was continued until September 3, give us important information. Referring to Table I., it will be seen that the benefit to the picked apples instead of being greater than that to the fallen fruit was last year about twenty-seven per cent. less, so that certainly no appreciable effect was produced by spraying during the life of the second brood. The greater injury to the picked fruit is readily accounted for by a circumstance to which I have already alluded; viz., that our experimental trees were surrounded by others upon which no experiment was tried, and were consequently subject to invasion by codling moths of the second brood, reared upon these unpoisoned trees.

Not only do these experimental facts point to the inefficiency of Paris green as against the later broods of the codling moth, but it is plain that the result was what we must have expected *a priori*. As the codling moth of all broods deposits the egg habitually on the blossom end of the apple, the poison taking effect only in case it reaches the surface of the apple between the calyx lobes, it is evident that there is little probability of effectively poisoning the fruit when the apple is full grown and pendent upon its stem.

DANGER OF APPLICATION.

Furthermore, I wish to emphasize especially the point that *spraying after the apples have begun to hang downward is unquestionably dangerous*, and should not be permitted under any circumstances if the fruit is afterwards to be used. The results of the chemical analysis reported last year show that even heavy wind and violent rain are not sufficient to remove the poison from the fruit at this season; and remembering that the stem end of the apple presents a large conical pit by which the poison could be received and held, where neither rain nor wind could dislodge it, we have additional reason for this absolute prohibition of the use of any poison dangerous to health, except when the fruit is young.

COMPARISON OF PARIS GREEN AND OTHER POISONS.

I made this year some further experiments, intended to test the relative efficacy of Paris green and a solution of arsenic* as applied to the codling moth, spraying two trees with the standard arsenic solution and two others with Paris green. The comparative results are shown in Table IX., from which it will be seen at a glance that, so far as these experiments are concerned, the advantage remains decidedly with the Paris green.† The damage to apples treated with Paris green appears, in fact, to be only about forty-two per cent. of that following treatment with arsenic, —the ratio being not materially different for picked and fallen fruit.

It will be remembered that I made a similar comparative experiment last year with Paris green and London purple, finding then, also, that the former poison was decidedly the more efficient. As only a single tree was treated with London purple, and as I see no sufficient *reason* why this substance should not act as efficiently as Paris green, I think that this result should not be insisted on. The facts, as made out, are given in Table X.

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* The white arsenic, as analyzed for me in the University laboratory, proves to have been of excellent quality, containing ninety-eight per cent. of arsenious acid.

† We further noticed a decided scorching of the leaves on the trees which were sprayed with arsenic, while those to which the Paris green was applied were entirely uninjured.

EFFECT ON CURCULIOS.

I have now merely to recall the results with respect to curculio injuries to the apple, derived from our last year's work, by which, it will be remembered, it appeared that about half the damage done by curculios was prevented by the Paris green. We kept a similar account of the curculio injuries this season, but their numbers were so completely insignificant as to give us no sufficient basis for computation, neither check nor experimental trees showing usually more than one or two per cent. of injury. It consequently remains for us to determine, another year, the effect upon curculio injuries of sprayings made only early in the season, while the fruit is small. As the curculios' work is distributed over a much greater interval than that of the first brood of the codling moth, the arsenical poisons, early applied, are much less likely to affect it in any important way.

I think we are justified, however, in this important conclusion; that the incidental benefit to the crop by such protection against the curculios as our sprayings gave, and especially such prevention of damage to the foliage as we know to be thus afforded, will fully compensate for the small expense of the Paris green application, which, made on a large scale, with suitable apparatus, only once or twice a year, must fall below an average of ten cents a tree.

CONCLUSION.

The experiments above described seem to me to prove that at least seventy per cent. of the loss commonly suffered by the fruit grower from the ravages of the codling moth or apple worm may be prevented at a nominal expense, or, practically, in the long run, at no expense at all, by thoroughly applying Paris green in a spray with water, once or twice in early spring, as soon as the fruit is fairly set, and not so late as the time when the growing apple turns downward on the stem.

Finally, I ought to add that my results are confirmed in general by the only other experiment that I know of in which the apples were examined with sufficient care and detail to permit a calculation of ratios of benefit. Last year, at the New York Agricultural Experiment Station, Mr. Goff, one of the officers of the station, sprayed six trees three times with Paris green, and brought them into comparison with four check trees not sprayed. The results of his experiment, as given in the Fourth Annual Report of the New York Agricultural Experiment Station, pp. 218-220, were to the general effect that sixty-nine per cent. of the apples were effectively poisoned, and that the loss by the codling moth was consequently diminished in that ratio. The whole number of apples examined in the course of his observations was 9,198.

TABLE I.

Paris Green, two trees eight times sprayed, and two trees as check, 1885.

FRUIT.	WHEN EXAMINED.	NO. OF APPLES EXAMINED.		INJURIES BY CODLING MOTH.					BENEFIT.
				Check Trees.		Poisoned Trees.			
		Check trees.	Pois'nd trees.	No.	Ratio.	No.	Ratio.	Corrected.	
Fallen	July 16	570	214	335	.59	16	.07	.03	.95
"	July 24	519	291	332	.64	73	.25	.18	.79
"	July 31	232	130	135	.58	17	.13	.06	.90
"	August 7.	117	141	64	.55	27	.19	.11	.80
"	August 27.	333	435	262	.80	109	.25	.07	.91
"	September 8.	88	61	73	.84	23	.38	.10	.88
Total fallen		1,859	1,272	1,201	.65	285	.21	.09	.86
Picked		1,105	1,147	811	.75	244	.21	.31	.59
Grand total		2,964	2,419	2,012	.68	509	.21		.69

TABLE II.

Comparison of Codling Moth injuries, 1885 and 1886.—Four trees each year.

FRUIT.	When examined.	1885.	1886.
Fallen	July 16	.51	.05
"	July 30	.49	.06
"	August 18	.47	.21
"	August 31	.80	.55
"	September 8	.55	.47
"	September 20		.57
"	October 4		.60
Total fallen		.56	.39
Picked		.70	.41
Grand total		.60	.39

TABLE III.

Snow Apple, one tree once sprayed with Paris Green, and one tree as check, 1886.

FRUIT.	WHEN EXAMINED.	NO. OF APPLES EXAMINED.		INJURIES BY CODLING MOTH.					BENEFIT.
				Check Tree.		Poisoned Tree.			
		Check tree.	Pois'nd tree.	No.	Ratio.	No.	Ratio.	Corrected.	
Fallen	June 8	54	100	2	.04	1	.01	.01	.75
"	June 25	47	.....	2	.04	.....	.....	.....	.....
"	July 20	533	807	23	.04	15	.02	02	.50
"	August 18	220	160	49	.22	18	.11	.10	.55
"	August 31	185	118	105	.57	40	.34	.22	.61
"	September 8	41	375	14	.34	78	.19	.16	.53
"	September 20	300	300	154	.51	121	.40	.33	.35
"	October 4	200	200	140	.70	79	.40	.20	.71
Total fallen		1,580	2,060	489	.31	347	.17	.14	.55
Picked		100	200	45	.45	35	.17	.22	.51

TABLE IV.

Snow Apple, one tree twice sprayed with Paris Green, and one tree as check, 1886.

FRUIT.	WHEN EXAMINED.	NO. OF APPLES EXAMINED.		INJURIES BY CODLING MOTH.					BENEFIT.
				Check Tree.		Poisoned Tree.			
		Check tree.	Pois'nd tree.	No.	Ratio.	No.	Ratio.	Corrected.	
Fallen	June 8	54	60	2	.04	0	.00	.00	1.00
"	June 25	47	40	2	.04	1	.02	.02	.50
"	July 20	533	248	23	.04	2	.01	.01	.75
"	August 18	220	190	49	.22	20	.11	.09	.59
"	August 31	185	83	105	.57	29	.35	.23	.60
"	September 8	41	234	14	.34	45	.19	.16	.53
"	September 20	300	300	154	.51	92	.31	.22	.57
"	October 4	200	200	140	.70	70	.35	.16	.77
Total fallen		1,580	1,355	489	.31	250	.18	.16	.48
Picked		100	100	45	.45	5	.05	.07	.84

TABLE V.

Snow Apple, one tree three times sprayed with Paris Green, and one tree as check, 1886.

FRUIT.	WHEN EXAMINED.	NO. OF APPLES EXAMINED.		INJURIES BY CODLING MOTH.					BENEFIT.
				Check Tree		Poisoned Tree.			
		Check tree.	Pois'nd tree.	No.	Ratio.	No	Ratio.	Corrected.	
Fallen	June 8	54	60	2	.04	0	.00		
"	June 25	47	48	2	.04	0	.00		
"	July 30	533	702	23	.04	4	.01	.01	.75
"	August 18	220	199	49	.22	24	.12	.11	.50
"	August 31	185	187	105	.57	51	.37	.26	.54
"	September 8	41	66	14	.34	24	.36	.37	
"	September 20	300	300	154	.51	91	.30	.21	.59
"	October 4	300	200	140	.70	75	.37	.18	.74
Total fallen		1,580	1,712	489	.31	269	.16	.13	.58
Picked		100	100	45	.45	6	.06	.08	.87

TABLE VI.

Two trees once sprayed and two trees twice sprayed with Paris Green, 1886.

FRUIT.	WHEN EXAMINED.	NO. OF APPLES EXAMINED.		INJURIES BY CODLING MOTH.					
				Once Sprayed.			Twice Sprayed.		
		Once sprayed	Twice sprayed	No.	Ratio.	Corrected.	No.	Ratio.	Corrected.
Fallen	June 8	800	98	1	.00	.00	0	.00	
"	June 25		509				1	.00	.00
"	July 20	1,788	368	21	.01	.01	3	.01	.01
"	August 18	401	325	32	.08	.06	28	.09	.07
"	August 31	213	283	87	.41	.34	47	.17	.08
"	September 8	431	484	88	.20	.17	73	.15	.09
"	September 20	600	600	211	.35	.24	113	.19	.11
"	October 4	400	400	179	.45	.28	96	.24	.11
Total fallen		4,569	2,705	626	.13	.10	352	.13	.09
Picked		409	250	72	.03	.22	7	.03	.04

TABLE VII.

Vandevere Apple, one tree twice sprayed with Paris Green, and one tree as check, 1886.

FRUIT.	WHEN EXAMINED.	NO. OF APPLES EXAMINED.		INJURIES BY CODLING MOTH.					BENEFIT.
				Check Tree.		Poisoned.			
		Check tree.	Pois'nd tree.	No.	Ratio.	No.	Ratio.	Corrected.	
Fallen.	June 8	55	38	0	.00	0	.00	.00	.00
"	June 25	9	107	1	.01	0	.00	.00	.01
"	July 20	35	120	6	.17	1	.01	.01	.94
"	August 18	230	135	54	23	8	.06	.05	.78
"	August 31	120	200	75	.62	18	.09	.04	.94
"	September 8	162	250	100	.62	28	.11	.05	.92
"	September 20	351	300	202	.57	21	.07	.03	.95
"	October 4	200	200	122	.61	26	.13	.06	.90
Total fallen		1,162	1,350	560	.48	102	.07	.04	.92
Picked		100	150	43	.43	2	.01	.02	.95

TABLE VIII.

Paris Green. General comparative exhibit of ratios of benefit.

1885	Fallen	Sprayed eight times	.86
	Picked		.59
	Fallen and picked		.69

1886	Fallen	Once	.74
		Twice	.77
		Thrice	.72
	Picked	Once	.48
		Twice	.90
		Thrice	.79

TABLE IX.

Comparison of Paris Green and Arsenic, two trees each, sprayed three times, 1886.

FRUIT.	WHEN EXAMINED.	NO. OF APPLES EXAMINED.		INJURIES BY CODLING MOTH.					
				Paris Green.			Arsenic.		
		Paris Green.	Arsenic.	No.	Ratio.	Corrected.	No.	Ratio.	Corrected.
Fallen	June 8	92	130	0	.....	.....	1	.01	.01
"	June 25	144	33	0	.....	.....	0	.....	.....
"	July 20	1,072	558	6	.01	.01	2	.00	.00
"	August 18	.....	294	.....	.....	.....	45	.19	.20
"	August 31	337	345	120	.36	.34	111	.32	.30
"	September 8	230	56	60	.26	.20	23	.41	.40
"	September 20	600	594	154	.26	.15	242	.41	.30
"	October 4	400	300	120	.30	.18	134	.45	.33
Total fallen		3,074	2,550	484	.16	.11	558	.22	.17
Picked		200	214	14	.07	.09	40	.19	.22

TABLE X.

London Purple, one tree eight times sprayed, and one tree as Check, 1886.

FRUIT.	WHEN EXAMINED.	NO. OF APPLES EXAMINED.		INJURIES BY CODLING MOTH.					BENEFIT.
				Check Tree.		Poisoned.			
		Check tree.	Pois'nd tree.	No.	Ratio.	No.	Ratio.	Corrected.	
Fallen	July 16	927	444	486	.52	154	.35	.25	.52
"	July 24	366	165	165	.45	82	.50	.54	.....
"	July 31	146	88	73	.50	35	.40	.33	.34
"	August 7	84	68	47	.56	27	.40	.29	.48
"	August 27	243	243	207	.85	171	.70	.36	.58
"	September 8	62	40	62	1.00	26	.65	.02	.96
Total fallen		1,828	1,048	1,040	.57	495	.47	.37	.35
Picked		208	157	158	.76	96	.61	.67	.19
Grand total		2,036	1,205	1,198	.59	591	49	.....	.17

A SECOND CONTRIBUTION TO A KNOWLEDGE OF THE LIFE HISTORY OF THE HESSIAN FLY

(*Cecidomyia destructor*, Say).*

In the valuable monograph on the Hessian fly published in the 3d Report of the United States Entomological Commission (1883), the following summary of the facts relating to the life history of the species is given:

"There are two broods of the fly, the first laying their eggs on the leaves of the young wheat from early April to the end of May, the time varying with the latitude and weather; the second brood appearing during August and the early part of September, and laying about thirty eggs on the leaves of the young winter wheat.

"The eggs hatch in about four days after they are laid. Several of the maggots or larvæ make their way down to the sheathing base of the leaf, and remain between the base of the leaves and the stem near the roots, causing the stock to swell and the plant to turn yellow and die. By the end of November, or from thirty to forty days after the wheat is sown, they assume the 'flaxseed' state, and may, on removing the lower leaves, be found as little brown, oval, cylindrical, smooth bodies; a little smaller than grains of rice. They remain in the wheat until during warm weather; in April the larva rapidly transforms into the pupa within its flaxseed skin, the fly emerging from the flaxseed case about the end of April The eggs laid by this first or spring brood of flies soon hatch; the second brood of maggots lives but a few weeks, the flaxseed state is soon undergone, and the autumn or second brood of flies appear in August. (In some cases there may be two autumn broods, the earliest August brood giving rise to a third set of flies in September)."

It was especially to test, for the latitude of Southern Illinois, the details of this, the current biography of the Hessian fly in America, that I commenced observations on the subject in Southern Illinois in 1883. The results thus far established show that in that latitude a large percentage, at least, of the flies emerge as imagos before wheat harvest or immediately thereafter (May 28 to June 28); that, if opportunity offers, the fly will breed

*For a previous contribution, which includes an account of the parasites, see 14th Rep. St. Ent. Ill., pp. 38-50.

freely in volunteer wheat at a date earlier than its usual breeding season in wheat of the regular sowings; and that the greater part of this midsummer generation emerge as winged flies before winter and lay their eggs immediately, thus giving origin to a third brood which hibernates chiefly in the puparium. In some instances, however, they pass the winter in various degrees of advancement, from the recently hatched larvæ to the fully formed semi-pupa. In the experiments on which the latter statements are based, the individuals of this third brood came to maturity in spring a little later than those of the usual fall brood, many of the pupæ being fully formed April 15, and the imagos commencing to emerge April 24.

Concerning the early transformation to the imago, of naked larvæ and recent "flaxseeds" (puparia) found in the wheat late in spring—from May onwards—I have only to add here to the data given in the 14th Report the following item derived from our collections of 1886. A lot of full grown larvæ with a few recent puparia collected from growing wheat in Lawrence county May 15, commenced to emerge on the 28th May* and continued to appear as winged flies until the 17th June. The history of the field in which this collection was made is peculiar and will be referred to later. It is further worthy of note that puparia obtained by me from the wheat at Edgewood, June 17, yielded a few imagos July 5.

Most of our observations and experiments for the present year were especially directed to a determination of the dates of the occurrence, in volunteer wheat, of the different stages of the insect, and to the mode of hibernation of the descendants of the midsummer brood.

IN VOLUNTEER WHEAT.

The occurrence of the larval fly in volunteer wheat in the latter part of summer or early in fall has been already reported more than once by farmers, but has commonly either been discredited, or reckoned an occasional phenomenon, due to exceptional conditions. To an inquiry addressed last spring to a number of observant farmers, and others of my acquaintance, I received several answers to the effect that the occurrence of the larval fly in volunteer wheat was a common event in Southern Illinois.

Mr. George H. Stookey, of Freeburg, writes: "In regard to the fly in volunteer wheat, if the stubble is plowed early—say in July—I think the flaxseeds occur late in August. I have noticed that when there is volunteer wheat, if it is plowed under or pastured off, the Hessian fly is not nearly so destructive to the following crop."

*The appearance of imagos May 24, 1887, from puparia collected at Edgewood, is to be added to the above. These imagos deposited eggs at once, as stated on another page.

Mr. Samuel Bartley, of Edgewood, says: "I think your suspicion as to the third brood of the Hessian fly is well founded—I think there is no doubt of it. I have several times plowed my wheat stubble as soon as the wheat was cut—not waiting to take shocks off the ground—and the volunteer wheat was nearly destroyed by the fly; and if I neglected to plow the ground the second time, before sowing, I would be nearly sure to fail in raising a crop on account of the fly."

From Mr. John Marten, of Albion, I had the following reply: "For three seasons past I have found the larvæ in considerable numbers on the *volunteer wheat after plowing the stubble under.* This was most extensively noticed last August, when I found an abundance of larvæ on volunteer wheat where plowing had been done. They were most abundant during the last few days of August and the first two weeks of September, after which I was not able to visit the field for some time."

Hon. David Gore writes from Carlinville: "I have observed the fly in volunteer wheat after the stubble had been plowed, but do not remember seeing it so far advanced as the flaxseed form."

Mr. F. Helms, of Heinrichtown, a farmer well acquainted with the fly in all its stages, sent me, in reply, the following interesting and important information:

"I have found the Hessian fly (flaxseed stage) in volunteer wheat every year for more than twenty years, some years in vastly greater numbers than others. The date of the formation of the flaxseeds seemed to depend on the time the wheat came up. I have seen them in the early part of September. In 1879 I sowed, for experiment, some ten acres of wheat about the 20th of August on strong land. The wheat made a quick start, and looked fine and well when about three or four inches high. The flies then deposited their eggs in great numbers, so that it was almost impossible to find a blade free from them. Dry warm weather followed, and the wheat was nearly killed by the fly (now in the flaxseed). The warm weather continuing long enough to allow the fly to hatch, the wheat then took a new start and made a fine pasture for sheep during the winter and early spring, and matured a good crop of heavy wheat."

Mr. W. H. Cotter, of Edwardsville, says that he has seen the fly in volunteer wheat in great abundance,—"particularly between the middle and the latter part of September;" and Mr. Jas. R. Miller writes from Caseyville substantially to the same effect.

Mr. F. C. Krinard, of Bunker Hill, Macoupin county, observed the volunteer wheat to contain the Hessian fly in as great numbers as wheat sown at any time during the season, if examined four or five weeks after its coming up.

IN EXPERIMENTAL SOWINGS.

For the purpose of securing more precise and complete data concerning the midsummer history of the fly in Southern Illinois, I selected for experimental midsummer sowings a field near Edgewood, in Effingham county, belonging to Mr. J. Lundberg, and one belonging to Mr. Aaron Young, at Billett Station, in Lawrence county, both of which had been too badly damaged by the fly to repay harvesting. These were, in fact, the only fields I was able to find in Illinois where the damage was last year sufficient for my purpose.

THE LAWRENCE COUNTY FIELD.—The history of this field was thus reported to me by the owner. It bore its first wheat in the summer of 1885—an excellent crop, showing no sign of the fly at any time. After harvest, the stubble was plowed between the 5th and 10th of July, and considerable volunteer wheat sprang up which became badly infested by the fly. This wheat was allowed to stand until *the last week in October*, when the ground was sowed again to wheat, put in with a double-shovel plow. This grain started well, but became, notwithstanding, somewhat infested with the fly that fall (1885), and May 1 of the following spring was seen to be badly damaged. On the 15th May, 1886, it contained great numbers of naked larvæ, with a few freshly formed puparia. From these larvæ, transferred to our breeding cages, we obtained several imagos May 28, and June 8 and 17. The wheat was so badly damaged that it was not harvested, but was plowed up in June and the ground planted in part to melons and in part sowed to wheat for my experiments.*

Four successive experimental sowings were made for me by Mr. Young, on lots each about one rod wide and ten rods long, the stubble being each time plowed for the purpose immediately before sowing. The first, made July 13, 1886, came freely, but was soon nearly all killed by a violent attack of a new, third brood of the wheat bulb worm, *Meromyza americana*—as detailed elsewhere. Enough remained, however, to afford a sufficient temptation to any flies that might be abroad in search of a place of deposit for their eggs. The second sowing, made July 28, suffered like the first. Between these two sowings, a neighboring field of wheat stubble was plowed, and soon produced a good growth of volunteer wheat, which was of great use to us later.

The third and fourth sowings, made August 5 and 19, grew well, and received no damage until attacked by the fly.

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*In a field adjacent, sowed October 10—much earlier, that is, than the infested wheat—no fly appeared either in fall or spring, but the grain was headed finely May 15, and ultimately made a good crop. It seems highly probable, therefore, that the flies which deposited their eggs in the later wheat came only, or chiefly, from the volunteer wheat in the fall of 1885, and that if these had been killed by complete and timely destruction of the volunteer wheat itself, the subsequent damage would have been prevented. It is also apparent that the remarkable fact of the destruction of the late sown wheat, while early sown wheat beside it escaped, is to be similarly accounted for. In the volunteer wheat the fly passed the period of early frosts in the relatively hardy state of larva or puparium, emerging later as the delicate and susceptible winged imago, and finding time between frosts to deposit its eggs in the young grain amid which it came to light.

My first visit to this field was made August 4, at which time two strips had been sowed, the wheat on the first being four inches high and that on the second just coming up. Several hours' search in the former plot gave no trace of the fly in any condition. A large number of plants sent to the office were carefully scrutinized, especially for the egg upon the leaf, but likewise without success. This wheat was badly damaged (as already said) by the third brood of the wheat bulb worm (*Meromyza americana*), one half to two thirds of the plants having been already killed by this insect. On the 20th August these plots were visited by my assistant, Prof. Garman, and the volunteer wheat mentioned above was also searched, but equally without result. The wheat was now almost exterminated by the bulb worm upon the first two plots, and these were thereafter left out of the account. Only small patches occurred where the plants were possibly thick enough to attract the imago.

On the 4th September I spent several hours in the *volunteer wheat* (which, it will be remembered, sprang up about the 20th July), searching in every imaginable way for eggs and larvæ, but finding nothing of the Hessian fly. Three hundred and seventeen plants selected from those least flourishing were sent to the office and there carefully searched, magnifier in hand, for both eggs and larvæ, but not one of either was detected.

Again, September 18, this field was thoroughly investigated, about two hours being spent by myself and several volunteer assistants in closely examining leaves and stalks and tearing the plants in pieces. Although several other dipterous larvæ and pupæ were discovered, some of them possibly injurious to the plant, not a trace of the Hessian fly was seen. The owner assured me, however, that he had the day before happened upon two puparia which he was certain were those of the species in question. Ten days later (on the 28th Sept.) I received from Mr. Young a small vial of alcohol, containing larvæ and puparia of the Hessian fly, the latter freshly formed, the former from half to full grown. These were taken by Mr. Young from the volunteer wheat, and were the earliest positive indications found that this wheat had been infested. As about three weeks* is required for the growth of the larva from the egg, the latter was probably laid for the larger larvæ not long after September 5.

The difficulty of finding in fields of wheat a few scattered examples of objects so minute as the egg of the Hessian fly, explains our failure to detect it at the time. Indeed it was not until the individual plants began evidently to suffer that it became at all easy to find even larvæ in the field.

October 11, I again visited Billett Station, and found numbers of larvæ and puparia of the fly, about one third to one half of the stalks being infested, and those containing the pupuria all dead. Probably a tenth of the specimens obtained were puparia, seven

*See next page.

tenths full-grown naked larvæ, and the remaining fifth, in various stages of growth, from half a millimeter upwards. Not unfrequently four or five larvæ were found in a single stalk, and as many as two in probably half those examined. The wheat was about six inches high—the dead stalks from three to five inches. One dark-colored broken puparium noticed contained the larva not yet pupated. In wheat brought in from the field at this time, eighty-six examples of the fly were found; twenty-two of them larvæ less than half grown and twenty-eight larger, twenty-four recent puparia, mostly formed since collecting, and twelve puparia whose deeper color showed their greater age. On the 5th November the wheat remaining in this field which had escaped the plow contained many puparia of the fly and an occasional nearly full-grown larva. In a strip of young wheat adjoining this (sowed Oct. 5), at this date just beginning to stool, an abundance of larvæ of the Hessian fly occurred,—mostly full grown, but a few of them young. As this wheat could not have appeared above ground before October 12, these larvæ must have developed from the egg within three weeks.

I ought to add that careful sweepings were made both in and around the wheat fields on all our visits, in the vain hope of obtaining the adult fly.

THE EFFINGHAM COUNTY FIELD.—Four sowings were made at Edgewood, as at Billett Station, and at similar intervals; but as only one, that made August 5, was successful, the others failing to germinate on account of the extreme drouth, this one only need be discussed. August 21, this wheat, although well up and large enough to contain the fly, gave us no evidence of its presence. Unfortunately no other visit was made here until September 22, and at this time larvæ of the fly were not uncommon in the field,—a few nearly full size, but most of them not over half grown. A number of these were transferred with the wheat to breeding cages, and commenced to form the puparium October 2, and to yield the fly October 22. Combining these data with those just given for the larva, we have a period of something over forty days for the development of the autumnal generation—the only part of its history not covered by these two observations being the time passed by the full grown larva before the formation of the puparium. This must vary greatly with circumstances, as the larva may even form its pupa case—if deprived of food—some time before it has reached its normal size. A period of six or seven weeks is probably about the normal one for a single generation fully supplied with food, under favorable weather conditions in fall. Other flies emerged October 29, and proceeded at once to lay eggs in the vial in which they were confined, the eggs adhering in a string as they were extruded from the body of the female.

October 12 I found this wheat from six to eight inches high, well stooled, with here and there a dead stalk containing puparia of the fly, but only rarely a naked larva,—probably in not five per cent. of the instances. Careful sweepings yielded no adults.

From these puparia, October 18, three adults emerged—two males and a female. These were confined, alive, in a small bottle, and the single female at once laid eggs freely on the sides of the bottle, but nowhere else. By the next morning after the appearance of these imagos, this single fly had perished after laying sixty-seven eggs.

On the 16th November, this plot of August wheat contained an abundance of naked larvæ, with a few recent puparia. A handful of wheat sent to the office contained one hundred and ninety-one immature specimens,—fifty-eight being darkened puparia, thirty-one puparia freshly formed, and one hundred and two larvæ of various sizes, from two millimeters up—the smallest seven averaging about two and a half millimeters in length. Search in the other wheat fields of this vicinity gave no evidence whatever of the occurrence of the fly.

If we scan now more closely the results in these experimental plots, we shall note in the first place a much later appearance of the fly than the reports of my correspondents had given reason to anticipate. While the letters quoted agree substantially that full grown larvæ and puparia appear in wheat from the last of August to the middle of September, our own earliest examples were obtained September 22 (Edgewood), at which time few or none of the larvæ were more than half grown; and the specimens sent from Billett Station on the 28th September were in about the same relative stage of advancement.

The late appearance at Edgewood might be reasonably attributed to the failure of the earlier sowings to germinate, no wheat being in condition to attract females in search of suitable places for the deposition of their eggs until about August 15 or 20. As the time for the maturing of the brood is seen, however, to vary little from six weeks at that season of the year, it is likely that at Edgewood the eggs were laid about September 21. On the other hand, at Billett Station, where the rain-fall was much more timely and abundant, there was no such failure of the earlier sowings; and we can only adjust the facts there observed to the theory of a normal earlier development of the midsummer flies by supposing that the overwhelming attack made upon the first two plots by the wheat bulb worm, prevented the female Hessian flies from resorting to the same wheat. Evidently, however, another season's experiments will be needed to explain these discrepancies.

A further item of interest appears when we compare the condition of the fields at Edgewood and Billett Station, October 12. At the former place, about ninety-five per cent. of the larvæ had formed the puparia, while at Billett Station no more than ten per cent. were so far advanced, the remainder being naked larvæ of all sizes, from the smallest up. This discrepancy is, however, explained without difficulty by the different surroundings of the fields. The one at Edgewood being the only tract in the entire region in which we were able to find before harvest any traces of the fly, it probably became infested only from the flies which de-

veloped in that field. These coming out among the young wheat found immediate opportunity for oviposition, and, following the usual habit of the species, proceeded to breed without delay. Here at Edgewood, consequently, we had a practically isolated experiment, not interfered with by invasion from without. At Billett Station, however, the fly was common enough throughout the country surrounding to do noticeable damage to fields not far away, and there, doubtless, the repeated entrance of outside imagos searching the country for growing wheat, lengthened out the time of oviposition and the development of the brood.

The isolation of the field at Edgewood gives us this further valuable information. It will be remembered that the larvæ collected there September 22, first formed the puparia on the 2d October, and gave the first imagos on the 18th of that month. Now, November 16, we found in this field an abundance of larvæ and puparia, most of the latter freshly formed,—necessarily descended, therefore, from the imagos resulting from the first brood of larvæ developed in this plot. We have here, additional and conclusive proof that the time required for the development of a brood from the appearance of the puparia of one generation (October 2) to those of the next (November 16) is, at that season of the year, about six weeks.

To the above record of observations for the experimental plots I need only add that a visit made November 23 to wheat fields near Albion, Illinois, revealed the same state of affairs with respect to the fly as occurred in these special cultures, about ten per cent. of the examples found being puparia, and the remainder naked larvæ, mostly full-grown. Both these latest observations at Edgewood and Albion were made during a period of severe frost and falling snow; and they consequently show beyond question the hibernation of the fly, in large part, as naked larvæ. This item in the history of the insect has been previously reported only by Mr. John Marten, of Albion, whose observations were printed in the "Fruit Growers'" Journal of Cobden, Illinois. I have not seen the article, but Mr. Marten kindly furnished me, March 22, 1886, the following abstract of it, so far as it relates to this subject:

"Beginning in October, 1883, my observations extended to near the middle of March 1884, during which time I examined several hundred of the larvæ. Many of them had not, up to the end of February, formed the puparia, or outer hardened skins, in which they usually pass the winter and undergo their final transformations. This, so far as I can learn, is a new feature in the habits of the fly; and it is exceptionally strange at that time, as during the period of observation we had a temperature of from 26° to 30° below zero, with intervals in which the fields were quite free from snow. This change (the forming of puparia) began to take place as early as October, 1883, but was not so marked in some fields as in others. The unchanged larvæ were found in two fields through January, 1884, and in one field which was well pro-

tected by trees, until February 28,—the last date on which they were found. All attempts at rearing these unprotected larvæ failed, some dying without forming puparia, while others formed puparia that were lighter in color and thinner than the normal form."

At the present time (November 26) fields near Albion, in White county, are in precisely the condition described above by Mr. Marten, about nine tenths of the flies being naked larvæ, and many of them very small.

The final fate of these hibernating larvæ can only be determined by observations next spring.*

[Imagos of the second brood emerging in our breeding cages before harvest, have not ordinarily laid eggs, neither made any apparent preparations for that duty,—a fact which has suggested to me the idea that these midsummer imagos were prepared by nature for an interval of waiting before giving origin to another generation, this interval corresponding to the period of barren stubble fields between harvest and the growth of volunteer grain. However, in one instance, imagos which emerged May 24, 1887, laid eggs at once in the vials where they were confined, and the occurrence of even four broods of the Hessian fly in Illinois becomes possible. Confirmation of this supposition is afforded by the occasional finding of puparia with living larvæ above the upper node of the stem as late as July 12, the eggs for which must have been laid on the upper leaf of the plant, and consequently at a date quite too late for the first or spring generation of imagos. June 30, 1887.]

SUMMARY AND DISCUSSION.

From all the foregoing we draw the following important practical conclusion,—that the development of a third (autumnal) brood of Hessian-fly larvæ derived from imagos which emerge after the first autumnal frosts, may sometimes make of no effect the practice of late sowing—at present the standard defense against the fly—or may even make late wheat more subject to injury than the earlier plantings. How this comes to pass will be seen when it is remembered that late sowing as a defense against the fly is a procedure based upon the delicacy of the winged insect and its sensibility to frosts. By postponement of wheat seeding until the first hard frost of autumn, it is hoped to get beyond the reach of

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*In our breeding cages these hibernating specimens (Edgewood) gave the imago in moderate number from April 28 to May 3, 1887, and the proof of a third brood in our latitude is consequently complete.

It must not be forgotten, however, in this connection, that both our own observations and those of others show that individuals of each generation may lie dormant in the puparium during the whole life of the generation following, finally emerging with the descendants of their original contemporaries. Those puparia which form in May and June may not yield the imago until September, and those which form in volunteer wheat in September may hibernate and emerge in spring. The division into several broods is consequently not complete, and will probably be found less and less so as one passes into more northerly latitudes.

I suspect that drought may retard the metamorphosis of the larva, and that the generations may follow each other more closely and rapidly in wet weather than in dry.

the flies, which these frosts will kill if in the imago stage. If, however, these winged flies have already bred in volunteer and early wheat, and if the early frosts find the insect in the hardy stage of larva or puparium, the flies emerging from these, as they mature, will often make their appearance *between frosts* and deposit their eggs on the youngest wheat accessible, before being overtaken by killing cold. As late wheat is then in a condition more tempting to the mother fly than that in earlier sown fields, it is, on the whole, more likely to suffer serious injury.

It seems to be sometimes the case, however, that a field of early wheat infested in autumn, in the usual way, will develop the imago of the regular autumnal brood so early that it may be again attacked by the second autumnal brood and destroyed before cold weather arrests the ravage. Whether, consequently, the wheat be sown early or late, it is very evidently important that particular attention be paid to the volunteer wheat in regions subject to injury by the fly. If the land were so handled that the volunteer wheat, rye, and barley were not allowed to spring up, or if they were killed everywhere as fast as they should appear, no midsummer brood could develop, and the fall grain would be much less liable to attack. The late wheat especially would be protected, and late sowing would have the desired effect.*

Neither spring wheat nor barley are raised in Southern Illinois, but it may be proper to add that if they were, they would greatly complicate the problem of protecting the wheat from the Hessian fly.

I believe, however, that a more valuable use of the facts in the case may be made than this. Although our knowledge of the fly does not lead us to believe that it is perfectly three-brooded, and does not even justify us in assuming that all the winged flies coming out before and soon after harvest will deposit their eggs in volunteer wheat if this is offered them, yet it is certain that a large part of them will do so; and our recent observations indicate that the residue which will, under these circumstances, delay their oviposition† until a moderately late sowing time, is so small that it would be unlikely to do any great harm. Or, in other words, our present information warrants us in saying that if the fly is given an opportunity to breed in volunteer wheat, and if the progeny resulting are destroyed before the transformation to the winged insect, damage by the fly would be greatly lessened, if not practically prevented, in the latitude of Southern Illinois.

The mode of procedure which here naturally presents itself is such a management of the land as will, first, encourage the growth

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*A dry season is usually favorable to insect development, but the Hessian fly has been considered an exception to this very general rule. It seems possible that this seemingly detrimental influence of dry weather may be due to the failure of volunteer wheat, and the consequent suppression of the summer brood.

†It is by most writers believed that the female imago cannot delay oviposition, but that living only a few days, she must lay her eggs at once, whether conditions are favorable to their development or not.

of volunteer wheat and, second, destroy this at a time to catch the progeny of the earlier breeding flies before they have had time to mature. Just what the details of this procedure should be, is a question for the farmer rather than for the entomologist; but I suppose that the conditions may best be met by plowing the stubble rather early, to give the volunteer wheat a chance to start, and then so timing the planting that this wheat may be killed by the final preparation of the soil (say with a rotary harrow) just before the grain is sown for the regular crop. In other words, what is wanted to give effect to this idea is a definite interval between plowing and sowing, and a final treatment of the soil such as will kill the volunteer wheat. It is not necessary that either plowing or sowing should be done at any uniform time, but only that the proper interval be preserved between them. For more precise indications we must wait until another year has given us an opportunity to verify this season's results and to reconcile, if possible, some discrepancies between our own observations and those of our correspondents; but the interesting fact remains that the early breeding of the fly in volunteer wheat is a weak point in its life history, of which we may reasonably hope to take advantage for the overthrow of this great enemy of wheat culture in Illinois.*

If it should prove to be true that a much larger percentage of the fly than I have estimated continues in the stubble in midsummer, we shall then simply have to revive, as an adjunct to the protective measure above outlined, a preventive method already often recommended; viz., that of using every opportunity to burn the stubble after harvest and to destroy the screenings from the thresher, in which such of the puparia will appear as were carried away with the straw. By a general practice of these precautions, it is now very likely that the Hessian fly could be in very great measure controlled.

I add two calendars summarizing in tabular form the entire mass of our data respecting the life history of the Hessian fly in the southern part of the State.† The first of these tables exhibits the dates and localities of all our collections and observations of the fly in its various stages, while the second presents an abstract of the results obtained by breeding only. The numbers in parentheses on the second table in the columns devoted to imagos and eggs, refer back simply to the figures at the left of the table, and indicate the original lots from which imagos and eggs were bred.

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*Fortunately the measure here recommended against the Hessian fly will be equally effective against a companion insect, sometimes scarcely less injurious, viz., the wheat bulb worm, *Meromyza americana*, since the second brood of this species occurs in volunteer wheat at substantially the same period as the fly.

†Complete to Dec. 30, 1886. The divisions between the broods are indicated by the heavy transverse lines in each column.

This history of the Hessian fly agrees closely with that of the wheat bulb worm, which insect is now also known to be unquestionably three-brooded. The period of the second brood coincides almost exactly with that of the Hessian fly, the third brood agreeing also, except that it is somewhat retarded in its later stages, hibernating only as a naked larva, and not reaching the imago stage until May,—nearly a month later, on an average, than the corresponding stage of the fly. The first brood of the Meromyza is correspondingly later than the other in its origin, but passes through its transformation more rapidly, development from the egg to the imago occurring, so far as our observations show, within the limits of a single month.

Calendar of the Life History of the Hessian Fly.

No.	Date.	Larvæ.	Puparia.	Imagos.	Eggs.	Remarks.
1	March 15.....		1886			Edgewood.
2	April 9.....		1884			Marshall.
3	" 10.....		1883	1883	1883	Centralia.
4	" 14.....		1883	1883		Centralia.
5	" 23.....			1886		From No. 1.
6	May 5.....	1883				DuQuoin.
7	" 15.....	1886	1886			Billett Station.
8	" 17.....	1883	1883			Odin.
9	" 19.....	1884				Albion.
10	" 21.....		1884			Marshall.
11	" 24.....	1883				Decatur.
12	" 25.....	1884	1884			Robinson.
13	" 26.....	1884	1884			Robinson.
14	" 27.....	1884	1884			Mt. Carmel.
15	" 28.....			1883		Bred from No. 6.
16	" 28.....			1886		Bred from No. 7.
17	" 30.....		1884			Carmi.
18	" 31.....		1884			Eldorado.
19	June 2.....	1884	1884			Robinson.
20	" 3.....		1883			Macoupin county.
21	" 3.....		1884			West Union.
22	" 3.....		1884			Villa Ridge.
23	" 4.....		1883			Bred from No. 6.
24	" 4.....		1884			Anna.
25	" 6.....		1884			DuQuoin.
26	" 7.....		1884			DuQuoin.
27	" 8.....			1886		Bred from No. 7.
28	" 12.....		1883			DuQuoin.
29	" 14.....	1884	1884			Robinson, Young.
30	" 15.....			1883		Bred from No. 6.
31	" 17.....		1886			Edgewood.
32	" 17.....			1886		Bred from No. 7.
33	" 17.....		1884			Robinson.
34	" 17.....			1884		Bred from No. 22.
35	" 18.....		1884			Anna.
36	" 20.....		1884			Robinson.
37	" 20.....			1884		Bred from No. 10.
38	" 20.....			1884		Bred from No. 22.
39	" 22.....			1884		Bred from No. 24.
40	" 22.....			1884		Bred from No. 21.
41	" 24.....		1884	1884		Robinson.
42	" 24.....		1884			Anna.
43	" 25.....		1884			Marshall. Contain living larvæ.
44	" 26.....		1883			Warsaw.
45	" 27.....		1884			Robinson.
46	" 28.....			1884		Bred from No. 41.
47	" 28.....			1884		Bred from No. 21.
48	" 29.....		1883			Godfrey.
49	" 30.....		1883			Jerseyville.
50	" 30.....		1884			Contain living larvæ.
51	July 1.....		1884			Marshall.
52	" 4.....		1883			DuQuoin.
53	" 5.....			1886		Bred from No. 31.
54	" 5.....		1884			Marshall.
55	" 7.....		1883			Effingham.
56	" 7.....		1884			Contain living larvæ.
57	" 9.....		1883			Villa Ridge.
58	" 12.....		1884			Anna.
59	" 20.....		1883			DuQuoin.
60	Aug. 5.....		1883			DuQuoin.
61	" 7.....		1883			DuQuoin.
62	Sept. 6.....		1883	1883		Centralia.
63	" 23.....	1886				Edgewood.
64	" 28.....	1886	1886			Billett Station.
65	Oct. 2.....		1886			From No. 63.
66	" 12.....	1886	1886			Edgewood.
67	" 18.....			1886	1886	Bred from No. 63.
68	" 20.....	1884				Robinson.
69	" 23.....			1886		Bred from No. 63.
70	" 29.....			1886	1886	Bred from No. 63.
71	Nov. 2.....	1886	1886			Billett Station.
72	" 16.....	1886	1886			Edgewood.
73	" 23.....	1886	1886			Albion.
74	Dec. 9.....	1883	1883			Anna.
75	" 27.....		1883			Albion.

Summary of Breeding-Cage Results.

No.	Date.	Larvæ.	Puparia.	Imagos.	Eggs.	Remarks.
1	March 15.....		1886			
3	April 10.....		1883	1883	1883	Centralia.
5	" 28.....			(1)*		
6	May 5.....	1883	1883			DuQuoin.
7	" 15.....	1886	1886			
10	" 21.....	1884	1884			Marshall.
15	" 28.....			(6)		
16	" 28.....			(7)		
21	June 3.....		1884			West Union.
22	" 3.....		1884			Villa Ridge.
23	" 4.....			(6)		
24	" 4.....		1884			Anna.
27	" 8.....			(7)		
30	" 15.....			(6)		
31	" 17.....		1886			Edgewood.
32	" 17.....			(7)		
34	" 17.....			(22)		
37	" 20.....			(10)		
38	" 20.....			(22)		
39	" 22.....			(24)		
40	" 22.....			(20)		
41	" 24.....		1884			Robinson.
46	" 28.....			(41)		
47	" 28.....			(20)		West Union.
53	July 5.....			(31)		
63	Sept. 22.....	1886				
65	Oct. 2.....			(63)		
66	" 12.....	1886	1886			
67	" 18.....			(66)	(66)	
69	" 22.....			(63)		
70	" 29.....			(63)	(63)	

*The figures in parentheses refer back to the original breeding-cage lot, as numbered in the left-hand column of the table.

ON THE LIFE HISTORY OF THE WHEAT BULB WORM (*Meromyza americana*, Fitch).

This beautiful and interesting insect develops, as our acquaintance with it improves, from the author of a conspicuous but insignificant mischief (as it was known three years ago) to a dangerous and occasionally very destructive secret enemy to wheat culture in the United States. Having published an elaborate account of it in my Report for 1883, I give here only a brief summary of the facts hitherto ascertained concerning its life history, with a report and discussion of the observations of the present season.

Previous to the publication of that article the species was regarded as single-brooded. I there gave, however, evidence of the existence of a second brood, summarizing the facts as follows:*

From the above we may infer with certainty the existence of two broods of this insect, the larvæ of one appearing in autumn and of the other in summer. It must be admitted also, that we have not excluded the bare possibility of a third brood, at least under favorable circumstances, which may develop in August and September in volunteer wheat and rye, or, possibly, in grass, or some other plant.

"Assuming that there is no such brood, we find the life history to be about as follows: The eggs from the autumnal brood of the flies are doubtless laid as soon as the wheat is ready for them. From these eggs the worms hatch in September and October, doing usually much damage to wheat in fall, but continuing the work in spring. By the middle of April they commence to pupate, but do not all complete this transformation before the middle of May. The pupal state lasts about a fortnight, the flies emerging from May 1 to June 1, or thereabouts.

"Late in May and early in June the eggs for the next brood are laid under and about the sheaves of the upper leaves of the now heading wheat and rye; and these hatching, the larvæ of the second brood make their way inward to the tender base of the young pedicel of the head, just above the upper joint. Here they

*Pages 21 and 22.

may be found feeding on the tissues of the stem from the middle of June to the first of August, by which latter date all have pupated and most have transformed to winged flies. These have been seen to emerge from the pupa at intervals from July 4 to August 5, and, in all probability, then remain in waiting for an opportunity to lay their eggs on the earliest wheat to appear."

A brief note in the Report for the following year (1884) p. 54, confirms the above account by mention of the occurrence of half-grown larvæ in rye October 31. It is now rendered probable, however, that these larvæ were descendants of an earlier brood by which the same rye had been infested, the field in which these occurred having been sown for pasture July 9. At any rate the observations of the present year in experimental wheat sown for the study of the life history of the Hessian fly, show unquestionably the existence of an additional brood in volunteer wheat in August and September, the corresponding stages of this insect occurring side by side with those of the Hessian fly, or possibly, on an average, somewhat earlier.

The inference of an additional brood was first announced in a paper read by me August, 1886, before the Entomological Club of the American Association for the Advancement of Science, a brief abstract of which was printed in the "Canadian Entomologist" for September, 1886. The same fact was also stated in a paper on "Entomological Progress in Illinois," printed in the "Prairie Farmer" for November 13, 1886.

My first notes of the year on this subject were made August 4, as the result of a visit to an experimental wheat plot sown July 13, at Billett Station, in Lawrence county. This wheat had sprung up finely and was at that date from one to four inches high. About a week earlier, the owner had noticed that it had ceased growing, or was even dwindling away, and now from one half to two thirds of it was dead, many of the plants entirely gone, and others with the central leaf withered and the growth of the plant arrested. The base of this dead leaf was always gnawed or eaten within the sheath, and in every case where the author of this mischief could be found (probably in about ten per cent. of the damaged plants) it proved to be the larva of Meromyza, varying from half size to full grown. On a single leaf the eggs of the species were found still unhatched. Additional larvæ, now full grown, were obtained from this field September 3. By the 5th September most of these had formed puparia, and the flies emerged September 28. From other larvæ obtained September 11, no Meromyza imagos were bred, but several of the commonest parasites of the species, *Cœlinius meromyzæ*, Forbes, appeared in the breeding cage about two weeks later.

From a plot of wheat sown at Edgewood, August 5, the larvæ were obtained on the 22d September, and a single adult Meromyza resulted October 22. Larvæ of this brood (or possibly the next) continued to appear in small numbers in our collections until the

12th October. During all this time no imagos could be got by widespread and diligent sweeping. On the 14th of that month, however, no larvæ occurred in the experimental plots, but a single imago was taken in the one at Edgewood. Again, on the 27th October, an imago occurred in our collection at Champaign. On the 31st October, 1884, half-grown larvæ were found in rye; on the 2d November a single larva occurred in wheat at Billett Station; and on the 16th November full grown larvæ were obtained at Edgewood. The passage from the second to the third brood of this species occurs, consequently, in October.

To these data I will only add the following record of times and places of occurrence of the imago of the third brood. This was taken in wheat at Danville on the 20th May; at Urbana on the 21st; at West Union, in Clark county, on the 24th; at Mt. Carmel on the 28th; at Anna on the 6th June; and at Champaign June 18, at which latter date the larvæ of the following generation were also already to be detected in the part of the stalk just above the upper node.

Besides my own contributions, we have a series of observations made by Mr. F. M. Webster, an assistant to the Entomologist of the United States Department of Agriculture, published partly in 1885* and partly October 30, 1886.† These observations, made in the same latitude as my own, confirm the interpretation of the facts here given and extend somewhat the periods of the different stages of the insect. They are incorporated in the calendar on another page, but need not be separately discussed.

Prof. A. J. Cook, of Michigan, reported in the "Prairie Farmer" for August 21, 1886, the frequent occurrence of the wheat bulb worm in the stems of oats, upon which it produced, of course, the same effect as upon wheat and rye. He also suggests the possibility of its working in autumn in volunteer oats.

These data may be generalized in the following summary account of the life history of the species. The eggs of the first brood are laid in May and June, the generation of larvæ resulting continuing into July, but commencing to pupate in June, and first reaching the imago stage early in July. These imagos doubtless live until August, during the early part of which month the eggs are laid for the second brood. The larvæ of this brood may be found in August, September, and October, transformations probably commencing during the latter part of August. Certainly imagos occur during September and October; and the eggs for the third or winter brood are laid in September, so far as observed. The larvæ resulting from these eggs in October and November, hibernate without transformation and continue until the middle

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*Rep. Com. Agr. for 1884, p. 389.
†Purdue Univ., School of Agr., Bull. No. 9, p. 5.

of May, some of them pupating, however, as early as the 5th April. Finally, the imagos from these pupæ appear in May and June.

We are, unfortunately, unable to say as yet whether this insect is dependent on an opportunity to breed in volunteer grain, whether it may breed in other grass-like plants, or whether it may, on occasion, suppress its midsummer brood and content itself temporarily with two generations a year.

The fact that the bulb worm occurs in volunteer wheat contemporaneously with the fly and in the corresponding stages, makes available for the control of this insect the measures recommended against its better-known companion. To recapitulate these briefly, if stubble ground be so managed as to promote a growth of volunteer grain at such an interval before seeding that the final preparation of the soil will destroy the young growth while the bulb worms infesting it are still too young to complete their transformation, this must necessarily check the multiplication of the pest, if it does not completely arrest it. There is, however, a possibility that this insect will be found to breed in volunteer oats as well as in the winter grains, in which case the method outlined above will probably be of less effect than for the Hessian fly.

One interesting feature in the natural history of this species still remains undetermined. At present no mode of hibernation of the Meromyza is known except that in the larva stage in winter wheat or rye; but the imago has been decidedly abundant in summer in regions where winter grain is raised in very small quantity, and where, nevertheless, it did not suffer noticeably from insect injuries.

We have here, consequently, grounds for the suggestion that this species may develop in other plants than the various grains which alone it has hitherto been known to attack.

Calendar of *Meromyza americana*, Fitch.

(The single figures in the columns indicate the number of the brood.)

No.	Date.	Eggs.	Larvæ.	Pupæ.	Imagos.	Locality.	Remarks.
1	Mar. 13..	.....	3	.....	.....	Cuba.....	Full grown .....
2	" 20..	.....	3	.....	.....	"	" .....
3	Apr. 10..	.....	3	.....	.....	"	" .....
4	" 12..	.....	3	3	.....	Centralia.....	.....
5	" 21..	.....	3	.....	.....	"	.....
6	" 27..	.....	3	3	.....	Heyworth	.....
7	May 4..	.....	.....	3	3	.....	Bred from No. 3.....
8	" 6..	.....	.....	3	3	Cuba.....	" " .....
9	" 8..	.....	.....	3	3	.....	" " .....
10	" 9..	.....	.....	3	3	.....	" " .....
11	" 10..	.....	.....	3	3	.....	" " .....
12	" 15..	.....	3	3	.....	Cuba.....	.....
13	" 16..	.....	.....	3	3	.....	Bred from No. 3.....
14	" 17..	.....	.....	.....	3	.....	" " .....
15	" 20..	.....	.....	.....	3	Danville	Scarce.....
16	" 21..	.....	.....	.....	3	Urbana.....	.....
17	" 23..	.....	.....	.....	3	Decatur.....	.....
18	" 24..	.....	.....	.....	.....	West Union	.....
19	" 24..	.....	.....	.....	3	Normal.....	Swept from wheat and meadows.
20	" 28..	.....	.....	.....	3	Mt. Carmel.....	.....
21	" 30..	1	.....	.....	3	Decatur.....	From No. 17.....
22	June 1..	.....	.....	.....	3	Cuba.....	Bred from No. 12.....
23	" 6..	.....	.....	.....	3	Anna.....	Rare.....
24	" 6..	.....	.....	.....	3	Oxford, Ind.....	From wheat fields.....
25	" 14..	.....	1	.....	.....	"	Nearly full grown.....
26	" 16..	.....	1	.....	.....	"	" " .....
27	" 18..	.....	1	.....	.....	Champaign.....	Wheat straws above upper node.
28	" 18..	.....	1	.....	.....	Kentland, Ind	.....
29	" 24..	.....	.....	1	.....	Oxford, Ind.....	.....
30	" 26..	.....	1	.....	.....	Warsaw.....	.....
31	July 1..	.....	1	1	.....	Cuba.....	.....
32	" 4..	.....	.....	.....	1	DuQuoin.....	Swept from wheat stubble .....
33	" 14..	.....	.....	.....	1	Anna	.....
34	" 18..	.....	.....	.....	1	Oxford, Ind.....	Emerging.....
35	" 21..	.....	.....	.....	1	Lafayette, Ind.....	" .....
36	" 26..	.....	.....	.....	1	Oxford, Ind.....	" .....
37	Aug. 4..	2	2	.....	.....	Billett Station..	Half to full grown.....
38	" 27..	.....	.....	2	.....	Indiana.....	In volunteer wheat.....
39	" 31..	.....	2	2	2	"	Emerging. Swept from buckwheat.....
40	" 31..	.....	2	2	.....	"	From volunteer wheat .....
41	Sept. 3..	.....	2	.....	.....	Billett Station	.....
42	" 3..	.....	.....	.....	2	Indiana.....	Bred from No. 40.....
43	" 5..	.....	.....	2	.....	.....	Bred from No. 41.....
44	" 5..	.....	.....	2	.....	Indiana.....	Swept from volunteer wheat....
45	" 6..	.....	.....	2	.....	Oxford, Ind.....	.....
46	" 7..	.....	.....	.....	2	.....	Bred from No. 40.....
47	" 7..	.....	.....	.....	2	Centralia.....	Swept from wheat stubble .....
48	" 10..	3	.....	.....	.....	.....	From No. 45.....
49	" 11..	.....	.....	.....	2	Billett Station.....	.....
50	" 11..	.....	.....	.....	2	.....	Bred from No. 45.....
51	" 13..	.....	.....	.....	2	.....	" " .....
52	" 16..	.....	.....	.....	2	.....	" " .....
53	" 20..	.....	.....	.....	2	.....	" " 40.....
54	" 22..	.....	2	.....	.....	Edgewood	.....
55	" 28..	.....	.....	.....	2	.....	Bred from No. 41.....
56	Oct. 1..	.....	3 ?	.....	.....	Indiana	Bred from volunteer wheat.....
57	" 6..	.....	.....	.....	.....	"	Swept from young wheat.....
58	" 7..	.....	3 ?	.....	.....	Billett Station.....	.....
59	" 12..	.....	3 ?	.....	.....	"	Half to full grown .....
60	" 14..	.....	.....	.....	2	Edgewood	Swept from young wheat.....
61	" 22..	.....	.....	.....	2	.....	Bred from No. 54.....
62	" 27..	.....	.....	.....	2	Champaign.....	Swept from young wheat.....
63	" 31..	.....	3	.....	.....	Normal.....	Half-grown, in rye .....
64	Nov. 2..	.....	3	.....	.....	Billett Station.....	.....
65	" 5..	.....	3	.....	.....	"	.....
66	" 16..	.....	3	.....	.....	Edgewood	.....

ON AN OUTBREAK OF INJURIOUS LOCUSTS IN CENTRAL ILLINOIS.

BY CLARENCE M. WEED.

In an article published as one of the series of "Miscellaneous Essays on Economic Entomology,"* issued from this office last year, the writer recorded a few of the more important facts concerning an outbreak of two common locusts—the red-legged locust (*Pezotettix femur-rubrum*), and the olive locust (*P. differentialis*)—which occurred in Central Illinois during the summer of 1885. I have there reported the approximate boundaries of the infested area, the extent of injury within that area, and such observations as I had been able to make upon the situation and condition of the locust eggs at the beginning of the winter of 1885-86. It is proposed in the present paper to bring the record up to the autumn of 1886, when the observations ceased, and to present a few general considerations which it is hoped may form a useful contribution to the subject of entomological prognostication.

In the paper above cited I have shown that a considerable proportion of the eggs had been destroyed by various insect and other enemies during the autumn of 1885,—the most useful of these enemies being the larvæ of the ground beetles (Carabidæ), and those of the blister-beetles (Meloidæ). Late in March, 1886, the region was again visited, and extended observations were made upon the condition of the eggs. The meloid larvæ were present, though in the quiescent coarctate condition in which they pass the winter; but many of the carabid larvæ had already begun to work upon the eggs. The most remarkable feature of the situation, however, was the extraordinary abundance of the red locust mite (*Trombidium locustarum*) which was everywhere present on and beneath the soil surface. At French Grove, March 22, these mites were just beginning to come out of the ground; and in many pastures from one to four of them could be seen on every square foot of surface. By the roadsides they also swarmed. At Monica, on the farm of Mr. W. E. Elliot, thirteen of the mites were counted within a surface area of one square foot.

*Rep. Ill. St. Bd. Agr. 1885, appendix, pp. 48–56.

These mites were repeatedly seen, both in the field and laboratory, in the act of sucking locust eggs; and I believe that they did more to check the outbreak than any other agency.

CONDITION OF THE EGGS.

It may be worth while to give here some of the details from my notes, showing the condition of the eggs in the French Grove region, March 22–24. In a pasture belonging to Mr. R. C. Davis, where the locusts had been exceedingly destructive, forty-nine egg-masses were found, thirty-two of which had been destroyed. In this field carabid larvæ and red mites were abundant and the coarctate larvæ of certain meloids were not uncommon. In a meadow on the same farm, where also great damage had been done the previous season, a single egg pod was found, the eggs having been destroyed. In another pasture, belonging to Mr. J. C. Slocum, five egg-masses were found, all of which had been injured. Three meloid coarctate larvæ were here taken, and several carabid larvæ. Twenty-seven of the pods were found in a pasture belonging to Mr. Jacob Moore, but twenty-two of them had been destroyed. Carabid beetles were here abundant, and a few carabid larvæ were seen, as were also two Epicauta or Macrobasis.

I next examined a forty-acre meadow belonging to Mr. Geo. M. Moore, which had been largely destroyed by the locusts the previous summer. A part of it had been plowed late in autumn, but I could see no difference in the per cent. of pods injured on the plowed and unplowed portions. Twenty-one egg masses were found, nine of which had been destroyed. The injured remains of three pods, and two others in which the eggs were intact, were found on the farm of Mr. Wm. Andrews. Along the roadside various situations were examined and four masses were found, two of them being uninjured.

Thus far, in the eleven situations examined there were found a total of one hundred and three egg-masses, seventy four (or about seventy-three per cent.) of which had been destroyed. This probably fairly represented the condition of the locust eggs throughout that locality at that time, as especial pains were taken to make examinations in fields remote from each other, and in which the conditions varied.

ABUNDANCE OF LOCUSTS IN 1886.

The region was not visited again until June 4 and 5, 1886, when the country about Elmwood, French Grove, and Monica was thoroughly examined for young locusts, which were then mostly about a week old. As a result they were found to be everywhere extremely scarce; and I did not hesitate to express the opinion that in all probability there would be no appreciable locust injury in that region during the summer of 1886. The red mites had evidently completed the good work begun by the carabid and meloid larvæ, and destroyed a large proportion of the eggs yet present at the opening of spring.

The developments of the summer justified the prediction just mentioned. No injury was reported, and the locusts were remarkably scarce throughout the region indicated.

THE CAUSES OF NEEDLESS ALARM.

While in Peoria county late in March I heard occasional rumors of the appearance of numbers of grasshoppers, but investigation showed that such rumors were usually founded upon the occurrence of one or two specimens, generally about woodlands. A little later, in Knox county, I heard a similar report, being informed that a farmer of unquestionable reliability had seen grasshoppers frequently in his meadow, and had specimens in his possession. On visiting the gentleman I found that the statement was indeed true, but that the insects were half-grown specimens of the common green-striped locust, *Tragocephala viridifasciata*. In the meadow where these had been taken, half grown individuals were, at the time of my visit, not uncommon, hopping about on the grass, although the ground, in many parts of the field, was covered with snow.

Specimens of the same locust were received April 9 from Mr. R. C. Davis of Peoria county, who wrote that they were very common in the woods about five miles north of French Grove.

The fact that this insect hibernates in the larval state has long been known to entomologists. Dr. Harris in writing of it nearly fifty years ago remarked:* "The larvæ or young survive the winter sheltered among the roots of grass and under leaves." And Dr. Riley has noted† that they are often the cause of unnecessary alarm concerning the visits of the Rocky Mountain locust, reports of the early hatching of this notorious species being based upon the presence of the young green-striped locusts during the mild weather of early spring.

This green-striped locust can be easily distinguished from either the red-legged or olive locust by the peculiar keel-shaped form of the thorax and by the broad green stripe on the anterior wings. "Like so many other species of its family it occurs in two well-marked varieties, one in which, in addition to the stripes on the front wings, the whole body and hind thighs above are pea green; the other in which this color gives way to pale brown. In both varieties the hind wings are smoky with the basal third greenish."‡

At the time of my last visit to the infested region (June 4 and 5) much apprehension prevailed concerning the seeming great probability of another locust attack. It was commonly believed that the pests were hatching by millions, but investigation soon showed that this also was a case of mistaken identity, the supposed

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*Insects Injurious to Vegetation, 3rd ed., p. 183.

†First Rep. U. S. Ent. Com., p. 255.

‡Riley: First Rep. U. S. Ent. Com., p. 256.

grasshoppers being only the various stages of certain leaf hoppers —by far the commonest species being the unfriendly leaf hopper *Jassus inimicus.*

As has so frequently been the case when our indigenous locusts have become destructively numerous, many people mistook them for the Rocky Mountain locust, and were unnecessarily alarmed concerning future attacks by this frightfully destructive pest. It seems useless to reiterate what has so frequently been said on this subject—that the Rocky Mountain locust has never, and in all human probability can never, become injurious in Illinois.

CONCLUSIONS.

The following general considerations bearing upon the subject of the destructive outbreaks of our indigenous locusts, and of the possibility of forecasting the future in any given locality where these insects are numerous, are mainly the result of the investigations recorded above. Of course no definite rules can be laid down by which predictions can be made. We can only indicate some of the factors to be taken into account in estimating the ratio of probability. In all cases the entomologist must carefully survey the field, and use his own judgment as to the importance due to each factor of the problem.

Besides the arthropodous animals mentioned below, various other agencies—such as the weather, epidemics of contagious diseases, etc.—must at times be taken into account.

1. Destructive outbreaks of our common locusts are liable to occur in restricted localities at varying intervals, whenever the climatic and other conditions favor their development.

2. There will generally be a gradual increase in the numbers of the locusts for a series of years, until the culmination is reached, after which there may be expected a great and sudden decrease.

3. The great majority of the eggs are deposited in grass lands, —especially in pastures and along roadsides,—and these situations should be examined for the eggs. Here, also, the young locusts will appear at a time when they are most easily destroyed by artificial means.

4. As a concomitant of this locust increase, there will usually be an increase of the Arthropoda which prey upon the locusts or their eggs; and it is generally owing to the fact that these enemies get the start of the locusts that the outbreak is checked.

5. Among the more important of these locust enemies which should be observed, and reckoned upon in prognosticating, are the following:

a. The red locust mite (*Trombidium locustarum*), which, when young, attaches itself to the locusts and sucks their juices; and later attacks their eggs.

b. The common species of blister beetles (*Meloidæ*), the larvæ of which prey upon locust eggs.

c. The larvæ and imagos of our common ground beetles (*Carabidæ*), which also destroy locust eggs.

d. A dipterous egg-parasite (possibly *Anthomyia angustifrons*, Meig.), which had destroyed many of the locust eggs in Knox county during the autumn of 1885.

Various other insect enemies may occasionally appear in significant numbers.*

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* For a discussion of enemies of the Rocky Mountain locust (the majority of which probably prey upon our indigenous species), see 1st Rep. U. S. Ent. Com., pp. 284-334.

ON SOME COMMON INSECTS INJURIOUSLY AFFECTING THE FOLIAGE OF YOUNG APPLE TREES IN THE NURSERY AND ORCHARD.

The Apple Tischeria.

(*Tischeria malifoliella*, Clemens.)

Order Lepidoptera. Family Tineidæ.

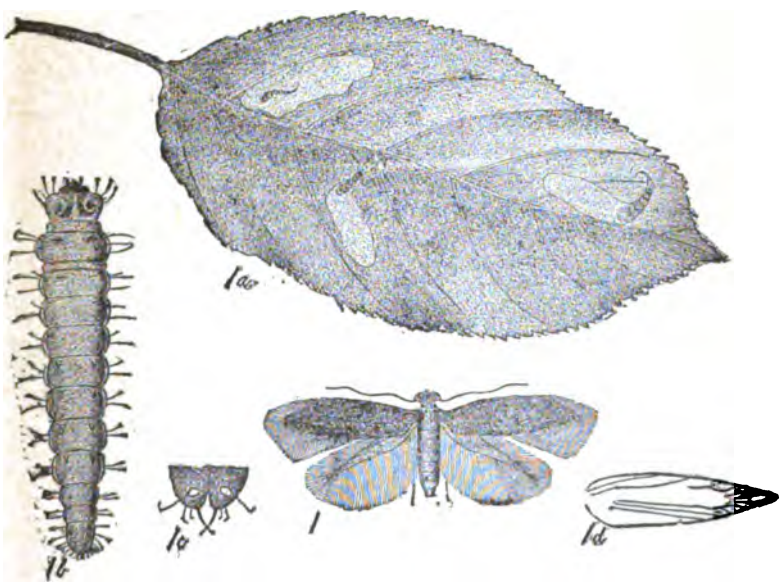

Fig. 1. *Tischeria malifoliella*, Clem. 1, adult moth; 1*a*, leaf showing mines; 1*b*, larva; 1*c*, ventral view of a portion of the anal segment of the larva, showing tentaculiform appendages; 1*d*, neuration of the fore wing.

[A small, green, footless larva, with a brown or black head, inhabiting a brown trumpet-shaped mine in the upper portion of the leaf.]

This abundant leaf miner was first described in 1860 by Dr. Brackenridge Clemens (Proc. Acad. Nat. Sci., Phila., Vol. XII., p. 208). He states that the larva mines the upper surface of the apple leaf, and that "the mine is flat, at least until the larva enters the pupa state, and begins as a slender white line, dilating as it increases, and is ultimately formed into an irregular brownish colored patch which is somewhat extended over the beginning. This is then shown on the separated epidermis as a white line or streak. The head of the larva is brown; the body uniform pale green; first segment brownish, with a short vascular greenish streak. When the pupation begins the leaf is thrown into a fold, which is carpeted with silk, and the pupa lies within it. This state begins about the latter part of September, and the imago appears early in May."

This description was again published by Mr. Stainton in his republication of Dr. Clemens's papers on "Tineina of North America."

The species is next mentioned by Mr. V. T. Chambers, of Covington, Kentucky, in Vol. III. of the "Canadian Entomologist" (p. 208), where it is noted as having been bred "from leaves of different species of Haw (Cratægus), Sweet-scented Crab (*Pyrus coronaria*), Blackberry (*Rubus villosus*), and Raspberry (*Rubus occidentalis*)." He adds that it probably mines other species of Rosaceæ. On page 50 of Vol. V. of the same journal Mr. C. again mentions this insect in connection with several others that "feed indifferently on the leaves of Cratægus, Prunus, and Malus;" and in the sixth volume (p. 150) he makes a similar mention of its food plants.

In the *Stettiner Entomologische Zeitung* (Vol. XXXIV., p. 222), Messrs. Frey and Boll publish a brief description of this insect from specimens found by them in Germany mining the leaves of apple-trees imported from America.

There was next recorded an additional food plant of the species —the dewberry (*Rubus canadensis*)—by Mr. Chambers, in the "Cincinnati Quarterly Journal of Science" (Vol. II., p. 111). He adds: "Prof. Frey and Mr. Boll mention having bred a species from the leaves of the blackberry (*Rubus villosus*), which they considered distinct from *malifoliella*, and described under the name of *T. ænea*. They also state that they have bred an allied species which they describe as *T. roseticola*. The species from the blackberry I have known for several years. I have not considered it distinct from *malifoliella*, Clem.; and I regard the specimens bred from all the species of Rubus, Cratægus, and Pyrus as belonging to the same species—*T. malifoliella*, Clem. *T. roseticola*, I have not seen; I incline to doubt its specific difference from *malifoliella*."

In an article on "Tineina and their Food-plants" (Bull. U. S. Geol. & Geogr. Survey, Vol. IV.) Mr. Chambers mentions this species in the list of those feeding upon Cratægus, *Pyrus coronaria*, and

P. malus, but omits it from the lists of those affecting Prunus and Rubus, giving under the three species of the latter, *Tischeria cenea*, from which we may conclude that he had changed his opinion about the identity of the forms found upon Pyrus and Rubus, and had decided to consider them as distinct species. *T. roseticola* is also given in this list as feeding on "various species of rose".

In his "Index to the Described Tineina of the United States and Canada," published in the same volume as the paper last mentioned, Mr. Chambers gives these three species under their separate names, and does not treat them as synonyms.

Finally, in 1883, Mr. A. E. Brunn published, in the Second Report of the Cornell University Experiment Station (pp. 155–157), an article on the "Tineidæ Infesting Apple-trees at Ithaca," in which he gives an excellent account of the life history and habits of this insect (under the common name of the Trumpet Mine of the Apple), together with illustrations of the mine, larva, and imago. Mr. Brunn states that this species is the "most abundant of the Tineidæ infesting the apple-trees at Ithaca, nevertheless it is not abundant enough to do them any material injury."

Of the mine and its inhabitant Mr. Brunn writes as follows:

"The mine, (see Pl. VI., Fig. 1*a*,) commencing in a glistening spot where the egg was laid, continues for a short distance as a narrow line, gradually growing wider, and then suddenly broadening out into an irregular expanded portion or 'body of the mine,' the whole having a trumpet-shaped appearance. The color of the mine on the upper surface is usually some shade of brown, although I have sometimes observed it to be dirty white. From the under surface of the leaf the mine would hardly be observed unless held up towards the light or examined closely, when the mined portion of the leaf would be seen to be of a lighter shade of green than the rest. The linear portion of the mine on the upper surface is crossed by crescent-shaped patches of white, which in many cases are continued for a short distance into the body of the mine. Often the miner after commencing the body of the mine will turn and eat around the linear portion, obliterating that part and causing the mine to appear like a blotch mine. In such cases the white crescent-shaped patches will be found somewhere in the body of the mine, indicating the position of the linear portion. These white markings are, however, wanting in some instances; but as the color of the linear portion of the mine is a little darker brown than the rest, we can still tell where the mine commenced. The position of the mine on the leaf is variable, it may be along the edge of the leaf causing it to curl over at that point, or along the midrib, or else between these points. As the leaf dries the mine assumes a tentiform shape.

* * * "If any foreign body is brought into contact with the long hairs covering the larva, it will be observed to support itself by some of its middle segments and rapidly vibrate the rest of the body,—this probably being the only way to frighten off parasites.

"The upper and lower surface of the mine of *T. malifoliella* is densely lined with silvery white silk. The excrement is deposited without the mine, through one or more openings which are situated at one end and on the lower surface of the mine. Within these clean and comfortable quarters the larva passes the winter. In the spring the larva transforms to a pupa, at one end of the mine, making no cocoon, and in a short time forces its way partly out through the upper surface of the mine, and there gives forth the moth. The tearing of either surface of the mine causes the larva to die, as it seems bound to get out if it can, and once out it can neither return nor build a new mine."

DESCRIPTION.

"*Larva* (Pl. VI., Fig. 1*b*).—Length, 5 mm. (.2 in.). Head small, pointed, retractile, and bilobed. Form flattened and tapering to the rear from the second or third thoracic segment. First thoracic segment twice as wide as head, but not as wide as the second thoracic segment. The last three abdominal segments are rounder and considerably narrower than any of the others. Between the first and second, and second and third thoracic segments are distinct folds. General color light green, with a brown, or even black, head. The large dark markings represented in the figure on the first thoracic segment are internal. No true legs, but four pairs of not very prominent prolegs, also anal legs. Three hairs on each side of the thoracic segment and two on each side of the remaining segments. Tentaculiform appendages and numerous hairs on anal segment. (Pl. VI., fig. 1*c*.) On each side of the dorsal surface of the third, fourth, fifth, and sixth abdominal segments there arise from the same point two short stiff hairs. A prominent ridge on each side of the lower, and two deep depressions on each of the thoracic segments."—Brunn (*l. c.*).

Pupa.— Mr. Brunn remarks that the pupa is unknown, the tineid having proved with him so difficult to rear, that he "hesitated about opening many mines," and is, "therefore, unable to describe the pupa." Out of a large number of mines examined, I have found a single pupa, which may be described as follows:

Length, 4.5 mm.; width, 1.2 mm. Antennal sheaths extending nearly to posterior end of third segment from last. General color light yellowish brown. A quadrangular space on dorsum of all the segments from the first thoracic to the third from the last abdominal, inclusive, has a darker brown ground color, the general appearance of which is rendered still darker by the short, stout, sharp-pointed tubercles with which the surface is studded; color of dorsum of head and thorax slightly darker than ventrum. Body sparsely furnished with moderately long, somewhat spinose hairs. On each side of front of head, which forms a blunt projection, arises a sharp, curved, horn-like process, projecting forward and outward, and which when viewed from the side is seen to be bidentate. Tip of last abdominal segment flattened, and furnished at edges with a row of short tubercles curving slightly forward.

This pupa is easily distinguished from that of *Ornix geminatella* by the horn-like projections of the head, the shorter antennal sheaths, and the row of tubercles on the last abdominal segment.

Imago.—"Head and antennæ shining dark brown, face ochreous. Fore wings uniform, shining dark brown with a purplish tinge, slightly dusted with pale ochreous; cilia of the general hue. Hind wings dark gray; cilia with a rufous tinge."—Clemens (*l. c.*).

The alar expanse is 7.5 mm. (.3 in.).

DISTRIBUTION.

I find that this species is very generally distributed throughout Illinois, being common in nearly all the nurseries and orchards examined during the past season. The specimens originally described by Dr. Clemens were presumably from Pennsylvania, and those bred by Mr. Chambers were probably found at Covington, Kentucky. Mr. Brunn reports it common at Ithaca, N. Y. Hence I believe that the following list includes all the American localities in which the species has as yet been recognized, though there is little doubt that it is found over a large portion of the states between and adjacent to the ones named:

ILLINOIS.—Bond, Champaign, Crawford, Edwards, Effingham, Jackson, Jefferson, Marion, McLean, Monroe, Randolph, St. Clair, and Washington counties. (Weed).

KENTUCKY.—Kenton, Co. (Chambers).

MICHIGAN.—Ingham Co. (Weed).

NEW YORK.—Tompkins Co. (Brunn).

PENNSYLVANIA.—Northampton Co. (Clemens).

LIFE HISTORY.

It will be noticed that a discrepancy as to the stage in which this insect hibernates occurs between the statements of Mr. Brunn and Dr. Clemens, the former saying that it passes the winter as a larva, and the latter, as a pupa. I have examined a large number of the mines late in autumn as well as throughout the winter and early spring, and never have found the pupæ earlier than April 9, up to this date the larvæ being invariably present.

Briefly recapitulated, the life history of the species is this: The small brownish moth deposits an egg on the surface of the leaf, from which there soon hatches a minute greenish larva which begins mining the leaf, making at first only a narrow mine, but gradually widening it as it grows older. When full grown it is about two tenths of an inch long, flat, with a green body and brown or black head. It pupates within the mine, and in due season emerges as a moth.

The apple Tischeria is very easily recognized by the peculiar mine of the larva, so that its presence can be detected at any sea-

son of the year. As will have been suggested from the statement of the way in which this insect hibernates, it may be very easily disseminated by means of young apple-trees from nurseries, either in the leaves that remain attached to the tree, or those which occasionally get into the packing boxes.

PARASITES.

Mr. Brunn (*l. c.*) bred two species of Chalcididæ, *Sympiezus lithocolletidis*, Howard MSS. and *Astichus tischeriæ*, Howard MSS., from the apple Tischeria. We have bred the former of these at Champaign, the species having been kindly determined by Mr. Howard, who writes that the descriptions of these species have never been published. Mr. Howard has also described* another chalcid, *Elasmus pullatus*, which was supposed to have been bred from the apple Tischeria.

REMEDIES.

I doubt whether the injuries of this insect in the orchard are ever sufficiently serious to repay the labor required for the application of the only remedy for the pest now known,—that of gathering and burning the fallen leaves; although I believe that this operation would pay in the nursery, where the leaves can be easily gathered, and several other injurious species would be destroyed at the same time.

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* U. S. Dep. Agr., Div. Ent Bull., No. 5, p. 94.

The Apple Ornix.

(*Ornix geminatella*, Packard.)

Order Lepidoptera. Family Tineidæ.

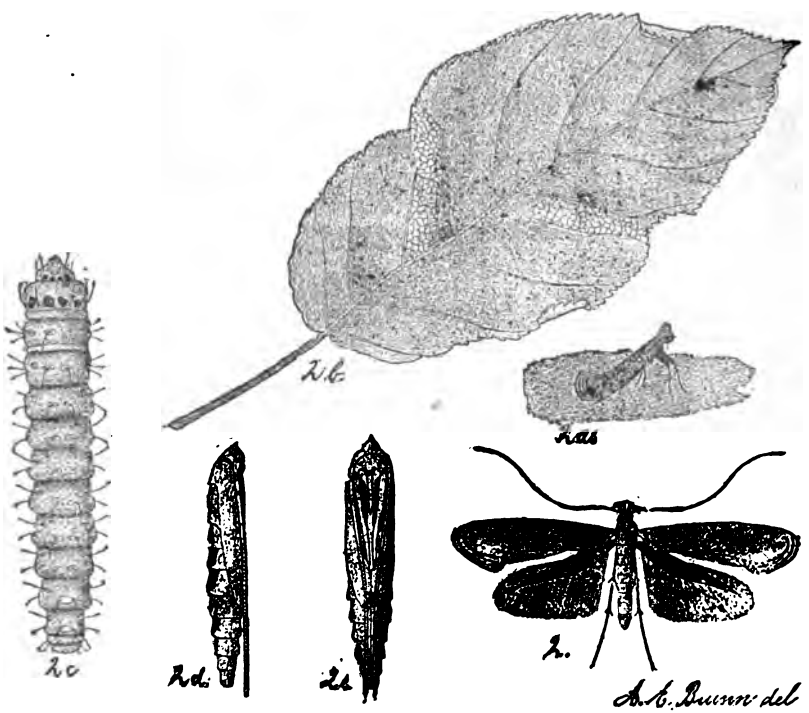

Fig. 2. *Ornix geminatella*, Pack. 2, adult moth; 2*a*, position of moth when at rest; 2*b*, apple leaf showing mines and cocoons; 2*c*, larva; 2*d*, lateral view of pupa; 2*e*, ventral view of pupa.

[A small, slightly hairy, worm inhabiting a tent-shaped mine on the under side of the apple leaf. When full grown, leaves the mine, making a silken cocoon in the upturned edge of the leaf.]

LITERATURE.

This insect was first briefly described as *Lithocolletis geminatella* by Dr. A. S. Packard ("Guide to the Study of Insects," pp. 353, 354; pl. 8, figs. 15—15c). The larva is said to have been abundant on the leaves of apple and pear in the vicinity of Salem during the summer of 1869. Dr. Packard writes: "The moth is of a dark slate-gray, without any prominent markings, with ochreous hairs on the top of the head. There is a black round spot on the middle of the inner edge of the wing. On the outer edge is an eye-like spot, pupilled with black like the 'eye' in a peacock's tail. The antennæ are dark, ringed with a pale slate color. It expands .30 of an inch. The larva is a pale livid reddish with a black head and cervical shield, and .14 of an inch in length. It was first discovered about the middle of August, hanging from a branch suspended by a thread. From this time it became abundant, until the leaves began to fall in the first week of October; nearly every leaf on some of the pear- and apple-trees having a mine. * * * Usually the larva draws two leaves together or folds one up, and as it eats its way along the surface of the leaf, leaves its excrement filling up the space behind, thus making blotches and otherwise disfiguring the leaves. In this mine it transforms into a long slender pupa, which may be found surrounded with the castings of the larva. The moths first appeared August 19, and flew in-doors at night attracted by the light."

This account does not exactly agree with the usual habits of the species, as observed by later writers, though in exceptional instances the larvæ may behave as here recorded. In the great majority of cases, as noted elsewhere in this paper, the larvæ do not pupate in their old mines, but make new ones by turning down the edges of the leaves.

The species is next mentioned by Mr. V. T. Chambers, in the "Canadian Entomologist" for November, 1871 (Vol. III., p. 183), where, in writing of the described species of the genus Lithocolletis, he says: "*L. geminatella*, Packard, is said to be dark slate-gray, without prominent markings, but with a round black spot on the middle of the dorsal margin, (like a Bucculatrix?) and an apical ocellus. The larva is pale livid reddish, (unlike any known Lithocolletis larva, but not unlike some Gracillariæ). It feeds on leaves of apple and pear trees, *between two leaves, or in a fold of a leaf.* (This is very unlike a Lithocolletis.")

In the "Canadian Entomologist" for March 1873 (Vol. V., p. 50), the insect is re-described as new by Mr. Chambers, (under the name of *Ornix prunivorella*), who gives Kentucky as its habitat. Of its life history he writes: "The larva mines the leaves of apple-trees (Malus), and wild cherry-trees (*Prunus serotina*), making a large tentiform mine on the under surface, which can only be distinguished from that of *Lithocolletis cratægella*, Clem., in the same leaves, by its larger size. It is at first a short, crooked mine, which ends in the large tentiform mine. It leaves the mine to

pupate under the edge of the leaf turned down. * * * I have never found it feeding on haw leaves. * * * It may be found in all stages through the summer and fall."

In the "Cincinnati Quarterly Journal of Science" (Vol. II., p. 301), Mr. Chambers, writing of the Tineidæ found in the far West, mentions having collected the mines of *Ornix prunivorella* in the leaves of wild cherry on the mountains, "both on Clear Creek, at Spanish Bar, and on Fontaine qui Bouille, near Manitou; altitude, 8,000 feet."

In the Bulletin of the U. S. Geological Survey, (Vol. III., p. 133), the same writer, in an article on the "Tineina of Colorado," remarks that this species is "found mining the leaves of the wild cherry in the mountains up at least to 8,000 feet altitude." Later in the same article, (p. 141), in enumerating the localities from which the species treated have been previously reported, he includes *O. prunivorella* in a list of seven species which have only been found in Colorado and in latitude 35° to 40° in the Mississippi Valley.

In an article on the "Food-plants of Tineina," published in the same connection, Mr. Chambers mentions (p. 111) this species as feeding upon wild cherry (*Cerasus serotina*), but, strangely enough, omits it from the list of those feeding upon apple, although, in connection with the original description, he remarks that "the larva mines the leaves of apple-trees." In this list *Lithocolletis geminatella* is not mentioned.

In 1882, Lord Walsingham, the eminent English authority on microlepidoptera, published in the Transactions of the American Entomological Society (Vol. X., p. 194), some "Notes on Tineidæ of North America." This paper was the result of a study of several American collections of these moths that had been sent him, many of the specimens being types of American species. On page 194, in speaking of certain of these specimens, he says:

"I think these may be *Ornix prunivorella*, Cham., although that author does not record that the larva of that species feeds on apple or pear. These specimens are not in good condition, and it is impossible, in so difficult a genus as Ornix, to be quite certain to what species they belong.

"They are the types of *Lithocolletis geminatella*, Packard, according to the label attached to the second specimen, but they undoubtedly belong to the genus Ornix."

From the statement just quoted, to the effect that Chambers does not record that the larva of *O. prunivorella* feeds on apple, it is evident that Lord Walsingham had been misled by the omission in the list of food plants noted above.

And finally the life history of the species is elaborately discussed, under the name *Ornix prunivorella*, by Mr. A. E. Brunn in the Second Report of the Cornell University Experiment Station (pp. 151–154; Pl. V.). This author applies to the

species the popular name of "The Unspotted Tentiform Mine of the Apple," and states that it is common about Ithaca, but not sufficiently abundant to be seriously injurious. He remarks that when the larvæ are nearly mature, they leave the old mines and make new ones. The latter operation is described as follows:

"Quite a dense but still very transparent covering is spun on the under side of the leaf. * * * While weaving these threads from side to side over the space to include the so-called mine, the larva rests on the threads already spun. In this way the larva may by its weight aid in causing the mine to assume its tentiform shape. When this covering is completed, the larva crawls in between it and the leaf, and completes the mine from the inside, by spinning more threads from side to side, and drawing the edges of the mine very close together. The under surface of the mine thus becomes more opaque from more silk being spun there and also as the silk itself, which is at first white, becomes brown."

Concerning the later history of the larva, Mr. Brunn continues:

"Soon the larva commences to feed, beginning at one end of the mine, and eating everything clean as it goes, excepting the small veins and upper epidermis. When through eating, or when all the parenchyma in the mine is eaten, the larva leaves the mine by an opening which it makes in the under surface, and either pupates in another portion of the same or a different leaf; or, if not through feeding, it makes a new tentiform mine on the disk of the leaf, or turns over the edge of the leaf, and feeds on the infolded portion. * * * The larvæ deposit the small, rounded pellets of frass in an irregular heap at one end of the mine.

"When about to pupate the larva leaves the mine through a small circular hole which it makes at one end and on the under surface of the mine, goes to some portion of the edge of the leaf, either on the upper or lower surface (very seldom on the lower), folds the edge over itself, bringing it close down to the surface of the leaf by silk, and then spins around itself, in this roll, a delicate silken cocoon. Within this cocoon it casts its larval skin and tranforms to a pupa, remaining in that condition throughout the winter. It takes less than twenty-four hours for the larva to make the roll within which it pupates. In exceptional cases the larva will spin its cocoon in the fold of the leaf caused by its mine, and at some distance from the edge of the leaf. Often the larva goes to the very tip of the leaf, and brings the two edges together, making its cocoon within this fold. The pupæ I have collected as early as October 3 and the larvæ as late as October 26. A young white larva which I collected November 6, turned gray upon placing it in alcohol. In the spring the pupæ transform to dark steel-gray moths, which, when at rest, assume the position shown in Pl. I., Fig. 2a."

NOMENCLATURE.

Lord Walsingham, in the paragraph cited above, states that Packard's species *geminatella* undoubtedly belongs to the genus Ornix, and that the type specimens then before him were probably the same as *O. prunivorella*,—a probability which would have doubtless been greatly strengthened in his mind had he not been under the erroneous impression that the latter species had never been bred from apple. Dr. Packard's figures agree very well with Chambers's description and with the excellent descriptions and figures of Mr. Brunn, as well as with specimens collected and bred by the writer.

In order to be as certain as possible of the identity of the two species I sent specimens of larvæ which, without doubt, belonged to the species described by Chambers as *prunivorella* to Dr. Packard with the request that he examine them to see if they were similar to the ones from which he bred *L. geminatella*. In response he writes as follows, under date of December 15, 1886: "I have examined the *Ornix prunivorella*—two larvæ—white, exactly of the size and shape of my *geminatella*, which I have not seen for nearly twenty years. Mine was a uniformly brown caterpillar, but the spots on prothoracic segment were not as distinct as appears in your specimen, yet in my figure I see they are represented I suppose the alcohol brings out the tubercles more distinctly than in life. It may be safe to regard the two species as the same, since Chambers bred it from the apple. On turning to Emerton's original drawing I see the spots on the thorax are represented just as in your specimen. My description on the sketch says: 'Color pale livid reddish, suspended by a thread to the tree.' On the whole, then, I conclude that the larvæ you send are those I described as *L. geminatella*."

The difference in the colors of these different larvæ may easily be accounted for on the supposition that Dr. Packard's specimen was not full grown, for, as has been remarked by Mr. Brunn, these larvæ are flesh-colored when young.

In the light of these various observations, the writer believes that he is justified in treating these supposed species as the same; and, as Dr. Packard's name has priority, in calling the insect *Ornix geminatella*, Packard.

DESCRIPTION.

Mr. Brunn has so carefully described the two earlier stages of this insect that I cannot do better than to quote his description in full.

"LARVA.—When full grown 6. 8 mm. (.27 in.) in length. Color grayish; when young flesh colored. Head light brown and about one half as broad as the first thoracic segment, which is light yellow. Form cylindrical with the last three or four segments of

abdomen tapering slightly. With the exception of the
first thoracic segment there are on the dorsal surface four longi-
nal rows of white elevations, each segment having at or near
middle one of these elevations in each row. There are also two
s of similar elevations on each side of the larva. Towards
caudal end of the larva the two middle dorsal rows run to-
ther. Other rows of tubercles disappear in the last abdominal seg-
nts, leaving fewer white elevations on these segments than on the
hers. From each of these elevations arises a hair of consider-
e length. On or near some of the tubercles of the middle dorsal
ws arises a second but quite short hair. Also numerous small
ts on the head, first thoracic segment, and anal segment. Upon
e dorsal surface of the head are four very black conspicuous
ots and on each lateral surface an indistinct one. Also on the
dorsal surface of the first thoracic segment are four similar but
larger black spots. Thoracic, abdominal, and anal legs well de-
veloped. The thoracic legs have the outer surface almost entirely
black and smooth while the inner surface is gray and furnished
with hairs. Abdominal and anal legs of same color as the larva.

Length.—Length from head to the end of the antennal sheaths
2 mm. Breadth at widest part 1 mm.

Head.—Head rounded beyond the anal segment. Antennal sheaths ex-
tending beyond the pointed head. Two rows of hairs on the dorsal surface
of the head, one on each side, the lower row on the sides being made up
of two hairs placed close together on each segment. No hairs
on the head. Color brownish yellow, with the exception of the
eyes, which is black, and the dorsal surface, which is brown or
brownish yellow. The color of the dorsal surface is due to a roughened
condition of the skin, which is brown in patches on all of the abdominal segments but the
last two, which are brown over the greater part of the dorsal surface
of each segment upon which it is placed, and extending nearly to the
segment next to the following segment. These dark patches
are not readily seen even in the cast off pupa skin."—Brunn,
Neb. Exp. Station, p. 153.

Imago.—Dark steel-gray, almost brown. Labial palpi white,
long, slender, extending externally with dark steel-gray. Antennæ of the
male about twice as long as the primaries with about nine faint whitish costal
spots, the first near the base, and the last at the apex,
the intervening spots gradually smaller from the base to the apex, all faintly
indicated, the last three or four nearly perpendic-
ular, the last two nearer the apex, the last at the apex,
the female antennæ slender

DISTRIBUTION.

Accepting the synonymy given above, the localities in which this species has been recognized may be summarized as follows:

COLORADO. (Chambers.)

ILLINOIS. Bond, Champaign, Crawford, Edwards, Effingham, Jackson, Jefferson, Madison, Marion, McLean, Montgomery, Monroe, Randolph, St. Clair, Wabash, and Washington counties. (Weed.)

KENTUCKY. Kenton Co. (Chambers.)

MASSACHUSETTS. Essex Co. (Packard.)

MICHIGAN. Ingham Co. (Weed.)

NEW YORK. Tompkins Co. (Brunn.)

This insect, like most leaf miners, may very readily be disseminated by the leaves that occasionally remain attached to young fruit trees during winter.

LIFE HISTORY.

The life history of this insect may be briefly characterized as follows: The grayish brown moth lays its eggs on the leaf, and the young larvæ as soon as hatched begin eating the parenchyma of the upper side of the leaf. When full grown they leave their old mines and make new ones by turning over the edges of the leaves. Here they pupate, and in a short time emerge as moths. They usually pass the winter in the pupa state, though, from the fact that I have found untransformed larvæ as late as November 24, I suspect that they may occasionally hibernate as larvæ.

PARASITES.

Mr. Brunn bred two species of parasites from the apple Ornix—*Sympiezus lithocolletidis*, Howard, MSS., and *Eulophus minutus*, Howard, MSS. We have bred from it a single undetermined chalcid, and a great number of a new species of Apanteles which I have described under the name of *Apanteles, ornigis.** These parasites spin peculiar, banded, white cocoons which are swung like hammocks within the leafy cocoons of the host.

REMEDIES.

The remarks concerning remedies for the apple Tischeria apply with equal force to the present species.

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*"Notes on Some Illinois Microgasters, with Descriptions of New Species." Bull. Ill. St. Lab. Nat. Hist., Vol. III., Art. I.

The Apple Leaf Skeletonizer.

(*Pempelia hammondi*, Riley.)

Order Lepidoptera. Family Pyralidæ.

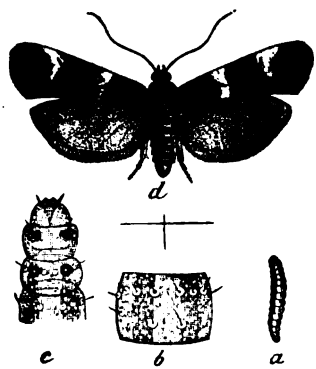

Fig. 8. *Pempelia hammondi*, Riley. *a*, larva, natural size; *b*, one of middle segments of larva, magnified; *c*, head and first three segments, dorsal view; *d*, adult moth.

[A brownish or greenish larva one half inch long, with scattered hairs, which spins a web on the upper surface of the leaf and eats the parenchyma, giving the foliage a scorched appearance.]

This insect is one of the most destructive species with which the nurseryman has to contend, nearly rivaling in the extent and seriousness of its injuries that species which I think must head the list of leaf-eating nursery pests—the lesser apple leaf roller (*Teras minuta*). It seems very generally distributed throughout Illinois, having been observed during the past season doing serious injury to apple-trees, both in the orchard and nursery, in McLean, Champaign, and Marion counties. It was first reported from this State a quarter of a century ago, and does not as yet seem to have become destructively numerous either in the Eastern or far Western States.

LITERATURE.

The first mention of this insect which I am able to find occurs on page 32 of Volume II. of the "American Entomologist," in a brief note concerning "Apple-tree Worms," being a reply to a query of Mr. H. K. Vickroy, of Champaign, Illinois, who had found the larva "doing considerable damage to the apple-tree" at that place. The editors there say: "These larvæ were first communicated to us by A. C. Hammond, of Warsaw, Illinois, early in September, 1868; and subsequently, at the Illinois State Fair, specimens were shown to us by W. T. Nelson, of Wilmington, Illinois. At the latter end of May, 1869, we bred the moth from them, and a full account of the species, illustrated by figures, will appear in the Second Annual Report of the senior editor. The mode in which this larva operates on the apple-tree is by tying together the leaves with silken cords, forming a mass of considerable size inside which it lives gregariously, skeletonizing the leaves that it has thus appropriated, and filling them with its gunpowder-like excrement. It was so abundant in 1868, near Warsaw and Quincy, as nearly to strip many trees, especially in young orchards that were in an unthrifty condition * * * * . To distinguish our species from the Rascal Leaf-crumpler, we may call it, in English, 'Hammond's Leaf-tyer' (*Acrobasis hammondi*, n. sp)."

But on account of the untimely death of the senior editor, Mr. Walsh, November 12, 1869, the Second Report alluded to in the above paragraph was never published, and the next mention of the species occurs in Dr. Riley's Fourth Report as State Entomologist of Missouri (p. 44), where its life history and habits are treated of, the descriptions being accompanied with illustrations of the moth and larva. Concerning its habits and the effect of its injuries, Dr. Riley writes as follows:

"In the fall of the year the foliage of trees in young orchards, and especially in the nursery, often wears a blighted, corroded, rusty look, and upon carefully examining it such appearance will be found to result from the gnawings of this little Skeletonizer. A badly infested orchard or nursery presents such a decidedly seared aspect that it attracts attention at a great distance; and while traveling by rail I have often pointed out the work of this insect and felt as sure of its presence in certain orchards, as though I had closely examined the trees.

"The rusty appearance is produced by the worm's feeding solely on the green pulpy parts of the upper surface of the leaf, and thus leaving untouched the more fibrous frame-work. In some cases the pulpy portions are eaten off very thoroughly, so that nothing remains but the semi-transparent epidermis below, and the net-work of veins; but more usually a certain amount of the parenchyma is left, and this it is which acquires a bright rust-red appearance. The worm always covers the leaf with loose tender silken threads, with which it mixes numerous little black,

gunpowder-like excrementitious grains; and it is under this covering that it feeds. It is semi-gregarious, either living alone on the leaf, or in company within a bunch of leaves tied together. * * * * So far as we now know there is but one annual brood of the Apple-leaf Skeletonizer; but the moths issue very irregularly, and the worms may be found all through the summer, but particularly in the fall, as long as the leaves remain on the tree. I have found but partially grown worms as late as November—unfortunates that seemed doomed to a wintry death. The moths commence to make their appearance in the vicinity of St. Louis by the first of May, but I have had them issue as late as the last of July."

In a letter from Mr. A. C. Hammond, published in the same connection, there is described a peculiar effect of the attack of these skeletonizers which is not mentioned in any of the later articles concerning the species, and which I have never seen in the field—that of causing the fruit to fall when about one fourth grown. In the orchard in question the larvæ were at work in great numbers in June, 1869, and it was "found that the worms generally inclosed two or three apples within the mass of leaves, and that they were feeding upon these as well as upon the leaves, of course causing them to drop." Mr. Hammond adds: "Their ravages were principally confined to a few varieties. The yellow Bellflower, Winesap, and Ben Davis appeared to be their favorites. They had caused fully one half of the fruit to fall from several hundred trees in my orchard."

Mr. Riley also records having bred from the larvæ of this species "two small Ichneumon flies, one of which is a Microgaster" which, he says, were accidentally destroyed before being described; and mention is made of the fact that "the larva of some lace-wing fly (Chrysopa) also preys upon it."

In a treatise on the Economic Entomology of Illinois, published in the Seventh Report of the State Entomologist (1877), Prof. G. H. French quotes (p. 252) portions of the two articles above referred to, but gives no original observations and adds nothing to the existing knowledge concerning the subject; although the recommendation is here first made that the arsenites be used as a remedy.

In an article concerning "Orchards and Insects" published in the Transactions of the Iowa State Horticultural Society for 1882, Hon. J. N. Dixon, of Oskaloosa, Iowa, discusses the skeletonizer and several related species, including the lesser apple leaf roller (*Teras minuta*), stating that both these species are single-brooded in his latitude. But as—while dissenting in part from the results of previous writers and claiming to have originally and independently worked out the life histories of these species—he falls into the only error they have made,—that of considering *Teras cinderella*, Riley, *and Teras malivorana*, LeB. (recently proven, as stated elsewhere in this paper to be dimorphic forms of one species—the *Teras minuta* of Robinson) as distinct species; and as he states

that both these species always pupate "under the surface of the ground and never in the leaves," while generally at least the reverse of this is the case, his assertion may reasonably be doubted. Mr. Dixon recommends for the whole list of leaf-eating orchard insects what he calls the "tramping remedy," which consists simply in pasturing various kinds of stock in the orchard. He also advocates spraying the foliage with white arsenic in water solution.

In 1883 Mr. Wm. Saunders published a short article concerning this insect in his excellent treatise on "Insects Injurious to Fruits," but records no original observations, and adds nothing to our knowledge of its life history.

No further records of observations upon this insect were published, so far as I am aware, until 1884, when Prof. S. A. Forbes noted the damage done by it in nurseries in McLean county, Ill., mentioning the suggestive fact that varieties having thick or woolly leaves are least liable to injury (Trans. Ill. St. Hort. Soc., 1884, p. 124; 14th Rep. St. Ent. Ill. pp. 97, 98).

In Bulletin No. 11 of the Division of Entomology of the U. S. Department of Agriculture (p. 20), submitted in January, 1886, Mr. F. M. Webster reports the results of some experiments on this insect made with soluble pinoleum and Hammond's slug shot. A solution of fifteen parts of the former substance with eighty-five parts water was sprayed over the leaves September 15, the result being that "probably seventy-five per cent. of the larvæ were destroyed; but full grown larvæ were observed on the leaves October 1." Leaves seriously affected by larvæ were dusted with slug shot September 15, when no dew was on them, the result being that the next day fifty per cent. of the larvæ were dead. Other applications followed with similar beneficial results.

DESCRIPTION.

The following are the descriptions of the three stages of the insect, as given by Riley (4th Mo. Ent. Rep., p. 46):

"*Larva.*—Length, 0.45–0.50 inch. General color olive, or pale green, or brown, with a broad dark stripe along each side of back. Tapers slightly both ways, joints 4–12, inclusive, divided into two transverse folds. Freckled with numerous pale specks and with piliferous spots, the specks often taking the form of two pale broken lines along the upper edge of dark stripe. The piliferous spots are pale with a central black dot, and are best seen in the dark specimens. On joints 4–12, inclusive, they are placed four in a square on the middle of the back, and four more each side, the two upper lateral ones being on the anterior fold, the stigmata appearing as minute rufous specks between them. Both these spots are often double. The third lateral spot is on the posterior folds, and the fourth is subventral and anterior. The hairs proceeding from these spots are long and setaceous. Head horizontal,

freckled, pale behind, tinged with green in front and with a few long hairs. Joint 1 also freckled and with a large black piliferous tubercle with a pale basal annulation and in range with middle of dark stripe. Joint 2 with similar black tubercles with a white center and replacing the uppermost lateral pale spot. There are but two of the small pale dorsal piliferous spots on this joint, (between the tubercles), as well as on joint 3. Beneath immaculate, except that the thoracic legs have sometimes a few dusky dots.

"In the very dark specimens the head, cervical shield, and anal plate remain pale. The cervical shield is then well defined with four small piliferous specks at anterior edge, and the large shiny tubercle forms the extreme anterior angle.

"In many specimens the subdorsal dark stripe is obsolete or subobsolete, but even then the four black tubercles on joints 1 and 2 characterize the larva sufficiently.

"Described from numerous specimens.

"*Pupa.*—0.24 inch long; rather stout and short, with two minute diverging spines and a few stiff bristles at tip.

"*Imago.*—Average expanse 0.48 inch. Front wings glossy purplish brown with two silvery gray transverse bands dividing the wing on costa in about three equal parts, the basal band sharply defined outwardly and always extending to inner margin, the posterior band never extending more than half way across the wing, and generally not more than one third, ill defined. In some specimens the basal transverse band is quite narrow, with the basal space a shade paler than the median: in others the band forms a double line. In some specimens, also, a narrow pale transverse line outside the second band, and a pale terminal shade, are visible. Hind wings uniformly paler gray. Under surface glossy gray, with no marks, the front wings a shade darker than the hind. The male differs from the female in the basal portion of the antennæ being curved, and the curve filled with a tuft of scales.

"Described from numerous bred specimens."

DISTRIBUTION.

It is probable that when left to its own resources this insect would spread very slowly; but there is great danger of its being carried from place to place through the agency of man. Especially is it liable to be introduced with trees from the nursery, unless they are thoroughly stripped before being sent out, and no dead leaves allowed to cling about the roots or get into the packing boxes. A case in point is that of a fruit grower in Sangamon county, Illinois, who purchased trees from nurseries infested by the species and was afterwards greatly troubled by their presence. So far as can be learned the insect had not before been observed in the locality in question.

I am informed by Prof. C. H. Fernald, the well known authority on microlepidoptera, that this species does not occur in Maine, and that he does not remember having seen it in any collection made in the East. It is quite generally distributed throughout Illinois, however, and is reported from some of the adjacent states.

LIFE HISTORY

Most of the facts concerning the life history of the apple leaf skeletonizer are given in the above extracts; but the note slips of the State Entomologist's office prove one new point of importance which should here be given; viz., that this species, contrary to the opinion heretofore prevailing, is double-brooded, at least in the latitude of Central Illinois, and probably farther north.

A lot of larvæ obtained at Normal July 7, 1886, were transferred to breeding cages at Champaign and fed upon apple leaves. On the 12th July many had changed to pupæ and on the 25th of the same month the moths began to emerge. The breeding notes of the office for the years 1883 and 1884 show that moths of the second brood were similarly bred during each of those seasons from larvæ obtained in early summer; and on August 6, 1884, the adult moths were collected at Normal on the leaves of apple-trees in the nursery.

Briefly recapitulated, then, the life history of the species is as follows: The small purplish gray moths, expanding scarcely half an inch, lay their eggs, probably, on the leaves or tender twigs of the apple late in spring or early in summer, the larvæ soon hatching and beginning to eat the parenchyma of the leaves, and, as they grow older, spinning a slight protective silken web on the upper surface of the leaf, beneath which they continue their destructive work. When full grown they vary from an olive or pale green color to brown; are about half an inch long; and have four black shining tubercles on the back just behind the head. About midsummer these larvæ pupate in slight cocoons formed usually on the leaf, and about two week later the moths emerge. Eggs are laid by these for the second brood of larvæ, which form cocoons before winter sets in and hibernate as pupæ, the moths from them emerging the following spring. But this species is very irregular in its development, it being easy to find larvæ of nearly all ages almost any time during the season. The second brood is usually much more numerous than the first, and consequently the injury is most noticeable in September and October. I think it not impossible that in certain instances even three broods may be developed.

It is probable that the larvæ of this insect sometimes occur upon other trees than the apple, as specimens were received September 22, 1884, from Sangamon county, Illinois, with the statement that they were injuring the leaves of plums and quinces.

PARASITES.

Dr. Riley mentions having bred a Microgaster from the apple leaf skeletonizer. We have also frequently obtained specimens of an undescribed species belonging to the genus Bracon from the larvæ of this insect.

REMEDIES.

Concerning remedies, Prof. Riley (*l. c.*) says: "A little hand picking at the proper time would do much to prevent its injuries, and I incline to believe that it may be extirpated by dusting the trees with air-slaked lime." Prof. French has added the recommendation that the arsenites be used, and Prof. Forbes has advised, in addition to this, that the fallen leaves in the nursery be burned to destroy the pupæ.

Early in July, 1886, I made some experiments with Paris green on skeletonizer larvæ infesting nursery trees. The results showed that spraying with Paris green in the proportion of one ounce to eight gallons of water, effectually destroys the larvæ without injury to the tree; and from some partial experiments made at the same time, which were interrupted by a heavy rain storm, I incline to believe that half this strength of solution would be sufficiently effective.

The operation of spraying nursery stock with the arsenites or other insecticides is much simpler than is generally supposed. For stock of one year's growth all that is necessary is to go through the field, lengthwise of the rows, with a wagon containing a barrel of the solution, having a hand-force pump and spray nozzle attached, straddling about every tenth row, and spraying the five rows on each side. In this way a field can be gone over easily and rapidly and sprayed for the leaf roller, skeletonizer, and crumpler at comparatively little expense. I presume that for trees two or three years old it would be difficult to straddle the rows with an ordinary wagon without injuring them; but this difficulty may be easily avoided by omitting every eleventh row so that the wagon can pass through at any time.

Special pumps on wheels, with spraying apparatus attached, are now manufactured for the purpose of spraying various crops with insecticides, and these would serve the present purpose admirably.

The Leaf Crumpler.

(*Phycis indiginella*, Zeller.)

Order Lepidoptera. Family Pyralidæ.

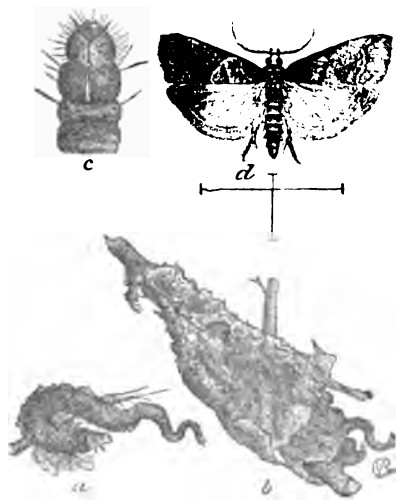

Fig. 4. *Phycis indiginella*, Zell. *a*, larva in its twisted case; *b*, crumpled mass of leaves containing a number of larvæ; *c*, anterior part of larva; *d*, adult moth.

[A brownish larva about three fifths of an inch long, living within a horn-like case surrounded by dead leaves. Hibernates as a larva within this case, which is attached to the twig. Eats young foliage in early spring.]

This is one of the commonest leaf-eating orchard insects. It is very generally distributed throughout Illinois and adjacent states, and often does serious damage to young fruit trees both in the orchard and nursery.

LITERATURE.

Zeller, in 1848, published the original description of this species under the name *Myelois indiginella*, in "Isis," a rare old German periodical issued at Jena, by Oken, between the years 1805 and 1848. The habitat of the insect is there given as "N. America."

The first recognizable notice of the species in American literature which I am able to find, occurs in the issue of the "Prairie Farmer" for August, 1851, where, in an editorial article entitled "A String of Bugs" (in which are discussed the principal insect pests of that time), the following paragraph appears:

"THE LEAF ROLLER.—One of the insects of this tribe is now very common in all this region and needs more attention than he has yet received. In the spring the insect is easily discernible by the little tuft of dry leaves which he has rolled up and cemented together for his winter quarters. In each tuft will be found a very small worm, and sometimes a half dozen of them, and the tree will be covered with their habitations. Later, and when the leaves appear—some of which are always near the house of the worm—one is laid hold of, drawn to the cell, and gradually devoured. The worm at this time, July 1st, is perhaps three fourths of an inch long; encased in a sort of tube made of leaves, web, and cement. Out of this he will stretch himself far enough to get hold of his food, and remain during the remainder of the time at leisure at home. In the spring, before the new leaves appear, the insects are easily found; and that is the proper time to attend to their case by picking off their nests and burning them. They fasten themselves on almost all fruit trees indiscriminately, but seem to prefer the apple, quince, and plum."

The next authoritative notice of the injuries of this insect appears in the "Prairie Farmer" for September, 1853 (p. 330), in an article by Dr. Wm. LeBaron of Geneva, Ill., entitled "Observations upon two Species of Insects Injurious to Fruit Trees." After treating at some length the life history and habits of the apple leaf hopper (*Empoa albopicta*, Forbes), the writer continues:

"The other injurious insect above mentioned is a leaf-rolling caterpillar, which I have seen briefly referred to in several numbers of the "Prairie Farmer", and which, therefore, I suppose to be somewhat extensively distributed throughout the West.

"This insect passes the winter in a half-grown larval state, and is rendered very conspicuous at this season, by the little clusters of dried leaves attached to the twigs of the apple- and plum-trees in which the larvæ lie concealed,—sometimes singly, but often two or three in company. Besides the covering of dead leaves each larva is enclosed in an elongated, conical, and somewhat twisted case, rough externally, but of fine texture and polished surface within.

"As soon as the foliage expands in the spring, the caterpillar begins to devour the leaves in its immediate vicinity, drawing them in around itself and confining them there by threads of web. It is thus enabled to feed at ease by protruding its body partially from the larger and open extremity of its case.

"The larva arrives at maturity about the end of June. It is then about two thirds of an inch long, sixteen-footed, pale dull green, with a brown head. It now slightly closes the mouth of its

case, and changes into the chrysalis state. Before the middle of July the perfect insects begin to make their appearance in the character of small gray moths belonging to the family of Tineidæ. The antennæ setaceous and simple; labial palpi long and recurved; maxillary palpi short and distinct; wings narrow and applied to the sides of the body when at rest. Length four and a half lines, or less than half an inch. Color light gray, slightly varied above with brown. Across the end of the wings are three oblique blackish lines, the terminal one consisting of a series of black points.

"The larvæ of this species, if permitted to multiply without check, would become a source of serious damage. Indeed, several years ago some of my plum trees became almost entirely covered with them. But by assiduously picking them off and burning them, my garden is now almost entirely free from them. In this operation I have been assisted by some of our winter birds, especially the tree sparrow (*Fringilla canadensis*), which I have seen busily tearing open the clusters of matted leaves in search, no doubt, of the larvæ concealed in them.

"I sent specimens of this insect, and also a description of the leaf hopper mentioned above to my friend Dr. Harris, of Massachusetts, and have been informed that he has not met with either of them in the Eastern States."

In the issue of the same journal for May 17, 1860, Mr. Walsh publishes an extended account of the life history of this insect, for which he proposes the scientific name *Phycita nebulo*, and suggests that it may be popularly known as the rascal leaf-crumpler. He had found the larvæ feeding on the leaves of apple, crab, and plum-trees.

The more important scientific portions of this article were republished in the Proceedings of the Boston Society of Natural History for 1863 (Vol. IX., pp. 312, 313).

There next appears in the "Prairie Farmer" for April 27, 1867 (p. 279), a note from a correspondent residing at Illiopolis, Ill., concerning a 'Worm on apple-trees, which is becoming very troublesome, and in many instances destroys the entire crop, and nearly always strips the trees of all early leaves." From the description given, Mr. Riley identified the insect as the leaf crumpler, and in reply gives a brief summary of its life history, with the following recommendations for its destruction: "There is no better method of destroying the worms than by picking and killing in winter, though you may do much quicker service by building fires in the orchard the latter part of June and July, into which the moths, unconscious of their fate, will plunge by hundreds, and thus a stitch in time will not only save nine, but fully ninety-nine."

Again in the issue of the same journal for August 3, 1867, appears the query of a correspondent from Franklin county, Iowa, concerning an insect "that is injurious to trees, fastening itself upon the limbs and killing them." Mr. Riley identified the insect

as the present species and writes: "It is very troublesome and numerous indeed this year throughout the State [Illinois]. As the worms remain in their silken cases through the winter the best manner of destroying them is to pluck them from the twigs at that season of the year, when they may be readily discovered, and to burn them. The moth which produces them should also be destroyed whenever seen."

About this time Mr. Walsh also received specimens of this insect from Iowa, and recommended the hand picking of the larval cases (Practical Entomologist, Vol. II., p. 18). The species was also briefly mentioned by Townend Glover in the Report of the Commissioner of Agriculture for the same year (1867, p. 73).

Again, in the "Prairie Farmer" for July 10, 1869, Mr. B. T. Taylor (residence not given, but presumably Illinois) publishes a note concerning an insect attacking apple-trees, which, from specimens sent, is identified by Dr. Riley as the leaf crumpler. The larvæ evidently were destructively numerous, for Mr. Taylor writes that after picking the leafy cases, one tree was left to see what effect the worms would have upon it. But when the injury that was being done was discovered, Mr. T. killed all the worms he could find, and expresses the opinion that had this not been done, the trees would have been defoliated.

In the "Canadian Entomologist" for July, 1870 (Vol. II., pp. 126-128), Mr. Wm. Saunders records the occurrence of the leaf crumpler on apple trees at London, Ont., and gives an excellent account of the life history of the species. There is here noted, for the first time, I believe, a habit of the larva, the effect of which may be seen on almost any infested tree—that of gnawing the green bark of the tender twigs. He suggests that this habit of "gnawing away all the young bark from and about the spot to which the case is attached, would in all probability lead sometimes to the girdling of the young branches and their consequent death." The breeding of an Ichneumon parasite from this species is also here recorded

Mr. D. B. Wier published in the "Prairie Farmer" for February 17, 1872, a lengthy article concerning this species, mentioning it in the introduction as an insect that "sometimes becomes very noxious, both in orchard and nursery." Concerning its winter and early spring history, he writes as follows:

"Like the black bear, winter finds it rolling in fat and securely housed, but spring finds it a most pitiable object indeed; its fat rounded abdomen of the fall before is shriveled to a mere point, the worm of half an inch scarcely measures an eighth; and it seems to be all head and no body. Yet it is lively and anxiously moves its house about in the warm part of the day, awaiting the pushing of the buds. As soon as the buds have swollen enough to expose the tender parts, it attacks the first it reaches and eats all its tender parts. By this our Phycita does us the greatest damage. If there are a great many on the tree they destroy nearly

all the leaf, as well as fruit buds, in this way not only spoiling the symmetry of our trees, but preventing a crop of fruit. It feeds most voraciously in early spring and soon finds its house of the year before too small for it, but, strange to say, instead of enlarging it, it begins to build a new one beside the old, which it securely fastens to the side of the old one, and carries both wherever it goes until it reaches maturity (?). * * * The rascal leaf-crumpler feeds upon the leaves of nearly the whole order Rosaceæ, but is most injurious to the apple among our domestic fruit."

This writer also records the discovery of a hymenopterous parasite, said by Dr. LeBaron to be a new species of Ichneumon. In some parts of the nursery nearly all of the Phycis larvæ were destroyed by these parasites, while in other parts it was said that none of them could be found.

As to remedies, Mr. Wier expresses the opinion that "There is perhaps no noxious insect that can be kept in check by labor alone easier than this." He recommends picking the cases and placing them in such a position that the larvæ will starve and the parasites escape; and adds the following paragraph concerning the application of lime: "Dr. Hull recommended a few weeks ago in this paper, air-slaked lime strewn over the leaves of trees as a preventive of this insect. The application would, I fear, be of little use, for the young larvæ are so snugly protected by their little houses that the lime would hardly reach them, and by their activity they would soon find some point uncontaminated by lime."

In the Fourth Annual Report of the State Entomologist of Missouri (pp. 38-42) Dr. Riley publishes a lengthy account of the species, which, he states, "sometimes become so prodigiously multiplied in young orchards, or in the nursery, as to seriously affect the health of the trees; for it does not confine itself to the leaves, but often in early spring commences on the swelling buds, attacks the young fruit, or gnaws the tender bark." He mentions it as "an insect which is quite common in the Western States, and which also occurs in Ontario, but does not seem to be known in the Eastern or extreme Southern States." He adds, "Though I have not met with this leaf crumpler in Southern Illinois, it nevertheless occurs throughout our own State, and is quite injurious in the southwestern counties." Concerning the food plants of the species he writes: "I have bred this insect from apple, cherry, wild and cultivated; plum, wild and cultivated; quince and crab-apple; and have noticed the cases on peach. Near St. Louis it has been, if anything, more injurious to quince than to apple-trees. Yet it does not seem to be able to live on the pear."

This author remarks upon the ease by which the pest may be subdued by hand picking, advising that the plucked cases "be thrown into some small vessel and deposited in the center of a meadow, or field, away from any fruit trees," where "the worms

will wander about a few yards and soon die from exhaustion and want of food, while such parasites as are well developed or in the pupa state will mature and eventually fly off."

Two parasites are here recorded as preying upon the species: *Tachina* [*Exorista*] *phycitæ*, LeBaron, and *Limneria* [*Banchus*] *fugitiva*, Say, the first having been bred by Dr. LeBaron, and the last by Mr. Wier. Excellent descriptions of the three stages of the insect are also published and a variety (*nebulella*) of the moth is characterized.

In a foot-note Dr. Riley states: "*Phycita nebulo*, Walsh, is *Myelois indiginella*, Zeller, as I am informed by the latter author, who has had occasion to examine specimens which I forwarded to him." But though Zeller's description of the insect was published twelve years before that of Walsh, and the identity of the two species is not questioned by Riley, he, together with many subsequent writers, has retained Walsh's name.

A short account of the life history of the leaf crumpler was published by Prof. G. H. French in the seventh of the series of reports upon the insects of Illinois (pp. 249–250), in which, however, nothing new was added to the existing knowledge concerning the species.

During the year 1878 this insect attracted some attention because of its injuries in the vicinity of Coldwater, Mich., where it was popularly called the leaf roller. Prof. A. J. Cook, by whom the facts were recorded (Trans. Mich. Pom. Soc. 1878, p. 22), recommended the hand picking of the larval cases and the application of Paris green as the most practicable remedies.

About this time the insect seems to have made its way into Georgia, if indeed it had not been there long before. In the "American Naturalist" for May, 1881, Dr. Riley notes the receipt of specimens of these larvæ (which he calls *Acrobasis nebulo*) from Bryan county, where they were reported to be doing serious damage.

In Mr. Grote's "New Check List of North American Moths," published in 1882, *Phycis indiginella*, Zeller, is given as the preferred name of the species, *nebulo*, Walsh, being mentioned as a rejected synonym. The only variety given is *juglandis*, LeBaron, a form affecting walnut, which, as Riley has shown (4th Rep. St. Ent. Mo., p. 42), should rank as a distinct species.

An excellent general account of the life history of the leaf crumpler appeared in 1883 in Mr. Wm. Saunders's treatise on "Insects Injurious to Fruits" (pp. 93–95); though in discussing remedies it is recommended that the gathered larval cases be crushed or burned, no mention being made of the seemingly better method noted above by which the parasites are allowed to escape.

Mr. F. M. Webster, in a paper read before the Indiana State Horticultural Society and published in the transactions of that society for 1885, briefly outlines the life history of the species, but records

no original observations, and does not definitely state whether the insect is found in Indiana or not; though from the fact that it is included under the general head of insects of the year, we may infer that it is a common pest.

In the issue of the "Fruit Growers' Journal" (Cobden, Ill.) for March 11, 1886, Prof. G. H. French, in writing of the condition of the orchards about Centralia, notes that in a two year old orchard visited "the leaf-crumpler (*Phycita nebulo*) seemed to be present."

DESCRIPTION.

Larva.—"Brown or greenish in color, cylindrical, tapering gradually from first to last joint. Head and cervical shield darker than the rest of the body, slightly shagreened, sparsely covered with long hairs, the shield quite large, convex, and occupying the whole surface between stigmata, there being in front of the latter a sub-cervical dark horny plate. Joints 2 and 3 wrinkled as at Figure 18, *c*, the former with two rather conspicuous dark dorsal piliferous spots. The other joints with a few fine hairs, the stigmata plainly visible, and the anal covering but slightly horny. Legs and prolegs of moderate size and of same color as body.

"Described from numerous specimens."

Pupa.—"Mahogany-brown with no striking character. Abdomen, especially above, with very minute punctures."*

Imago.—Mr. Walsh's description is as follows: "Expansion of wings, 7–10; length of body, 3–10. General color light cinereous, varied with dusky. A row of about seven subsemilunar or linear dark spots on outer margin of fore wing. Then one fourth of the distance to the body a waving light cinereous band parallel to the exterior margin, marked on each side with dusky black. Nearly at the center a much abbreviated black band. Beyond the center on the costal margin a subtriangular dusky black spot, the apex of which connects with the apex of a much larger subobsolete triangular brick red spot which extends to the interior margin, and is bounded on the outside by a wavy light cinereous band, which is again bounded by a wavy dusky black band proceeding from the apex of the costal triangle. Base of wing dusky black, enclosing a small round light cinereous spot. Hind wings and all beneath light cinereous shaded with dusky; the fore wings darker. Tarsi dusky with a narrow light cinereous fascia at the apex of each joint. Hind tibia fasciate with dusky at the apex, sometimes obscurely bifasciate. Intermediate tibia fasciate with dusky at the center, the fascia generally extending to the base, but becoming lighter. Anterior tibia dusky, with a narrow apical light cinereous fascia. Palpi, both labial and maxillary, dusky."

*Riley, 4th Mo. Rep., p. 41.

To this Dr. Riley adds:

"When compared with other closely allied and resembling species, this little moth may be characterized in the following manner: The ground color of the front wing is decidedly bright and pale; the discal spots are almost always confluent, thus forming an abbreviated transverse bar; the dark markings are well defined, and the triangular dark costal spot starting from the inner third of the wing is distinctly relieved, while the 'brick-red' (nearer a cinnamon-brown) triangular spot which opposes it is large, so that the space it occupies on the inner margin is nearly as wide (generally within one third) as that between it and the transverse posterior line. The lower half of the basal space is often of a distinct cinnamon-brown, and an oblique dusky band, which Mr. Walsh has not mentioned, is often quite distinct, running from near the apex to the brown triangle, where it connects with the inner margin."*

DISTRIBUTION.

This insect seems to be very generally distributed throughout Illinois and adjacent states. During the past season I have found it more or less abundant in the following counties of this State: Champaign, Crawford, Edwards, Effingham, Jackson, Marion, Madison, McHenry, McLean, Monroe, Montgomery, Perry, Randolph, Shelby, Stephenson, St. Clair, Union, and Wabash. In 1885 Professor Garman found it common in orchards at Mt. Pulaski, in Logan county, and the year previous the larvæ were collected at Du Quoin, in Perry county.

In the states adjacent to Illinois this pest seems to have a wide distribution. In the article from the Fourth Report of the State Entomologist of Missouri, quoted above, Dr. Riley writes that it "occurs throughout our own State and is quite injurious in the southwestern counties." In Tennessee, as I am informed by Mr. E. W. Doran, Entomologist to the Board of Agriculture of that State, it is "plentiful in most orchards" that he has examined; and Prof. F. H. Snow, of Lawrence, Kansas, writes that it is quite a common nuisance in his state. In Iowa it has long been known, though Prof. Herbert Osborn, of Ames, informs me in a recent letter that it "seems much less abundant than in the past." He adds: "While a common pest, it has never, to my knowledge, caused any widespread destruction in this State."

In the writings of Walsh and others, noted above under the head of Literature, it is stated that the species did not at that time occur either in Southern Illinois or New England. It seems, however, to have spread rapidly since, for it is now common in the first-named region, and, as I am informed by Prof. C. H. Fernald, occurs throughout New England. Is it not possible that it was merely overlooked twenty years ago?

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* 4th Mo. Rep., p. 41.

LIFE HISTORY.

Recapitulating the facts brought out in the various articles cited above, the life history of the leaf crumpler may be briefly given as follows: The small, grayish moths appear in June or July, and deposit eggs on the various trees which serve as food plants for the larvæ. From these eggs there soon hatch small brownish worms, which construct tubular silken cases, within which they remain concealed when not eating. As they grow larger they draw about the openings of their abodes many partially eaten leaves, so that by autumn there is quite a bunch about each case.

At the approach of cold weather the cases are attached to the twigs by means of silken threads, the larvæ frequently gnawing away the tender bark to insure a firm hold; and thus the winter is passed. As soon in spring as the leaves begin to appear the larvæ attack them, frequently eating out the flower buds as well. They continue feeding and growing until some time in June, when they become pupæ. Professor Garman found both larvæ and pupæ at Champaign June 13, 1885. About a fortnight later the moths emerge, and thus the life cycle is completed. In the breeding cages of the laboratory the moths have emerged as early as June 22 and as late as July 24.

From the references given above, and the note-slips of the office, it appears that the leaf crumpler feeds habitually upon the apple, quince, and possibly the peach, and on both the wild and cultivated varieties of the cherry, plum, and crab-apple.

INTRODUCTION INTO NEW LOCALITIES.

I know of no other orchard insect that is so liable to be generally introduced into new localities through the dissemination of young fruit trees as this, the peculiar winter habit of the species being such that, unless the trees are examined with special reference to it before they are sent out, a few of the larvæ are almost certain to adhere to them. Hence, both the person sending and the one receiving young fruit trees should be careful to pick off and destroy all suspicious looking leaf-masses. It may be argued that this pest is so generally distributed that it would make no difference were a few more to be introduced into each locality every year; but it does make a difference, for the balance which nature has adjusted between these insects and their various enemies is thus disturbed, and a new energy is infused into the work of destruction.

PARASITES.

Besides the parasites mentioned above by Dr. LeBaron and others, we have bred from this species an undescribed chalcid belonging to the genus Eupelmus.

REMEDIES.

There is no excuse, save that of gross negligence, for allowing these pests to injure young fruit trees. The larval cases are so easily picked off at a season when the orchardist has abundant leisure, that it is easy to find time to attend to them. I have been in several orchards the past season in which these larvæ were sufficiently numerous to seriously check the healthy development of the trees; and I doubt not that a similar condition prevails in hundreds of young orchards throughout the State. In some instances I have found trees so infested that there was a larva lying in wait for almost every bud; and it is needless to state that already the effect of past injuries could easily be traced in the diminished vitality of the trees. Doubtless the method, so frequently mentioned above, of placing the picked cases in an open field, away from trees, where the larvæ will starve and their parasites escape, is preferable to that of burning. Or, if the young trees are infested with any other of the several leaf-eating species, they may be killed by spraying with the arsenites, as recommended elsewhere in this paper.

In the nursery it is of the first importance that these pests should be destroyed; and the nurseryman owes it both to his patrons and to himself to see that the work is thoroughly done.

It is often difficult to convince those most interested of the easy practicability of picking these cases off of nursery stock. I have in mind an instance in which a nurseryman of unusual intelligence, whose apple stock was infested by the leaf crumpler, being advised by one of the leading entomologists of the State to put boys in the field to pick them off, regarded the idea as nonsensical and impracticable; and he was only convinced of the ease with which the work could be performed when shown the results of a practical experiment made to test the matter, in which a boy was placed in one of the infested fields with instructions to gather all the cases on the young trees. In two hours thirty rows three hundred yards long were gone over, and a half peck of the larval cases gathered. When shown this accumulated mass of destroyers, our friend was convinced, and at once hired boys to go over his fields. He afterwards expressed himself as surprised and highly pleased with the result. The larval cases were picked off of ten acres of one year apple stock, by two boys, in one and a half days.

The Lesser Apple Leaf Roller.

(*Teras minuta*, Robinson.)

Order Lepidoptera. Family Tortricidæ.

[A greenish yellow, slightly hairy worm, about half an inch long, affecting the young leaves of the terminal twigs. Pupates in the rolled leaves, and emerges as an orange moth in summer, or a gray one in autumn.]

The lesser leaf roller has been seriously injurious in Illinois for more than twenty years, and must, I believe, rank first in the list of leaf-eating nursery insects. Beginning its attack as soon as the leaves have partially unfolded, and affecting largely the terminal twigs, it is capable of doing great damage by checking that straight upward growth so necessary for a successful nursery tree, and causing the throwing out of side branches, which give to the tree a stunted, scraggy appearance.

LITERATURE AND NOMENCLATURE.

The literature relating to this insect is in a peculiarly chaotic condition, owing to the fact that it has been described by five different entomologists under as many different specific names. These various names have been held good by most writers until within a few years, and the insect has been frequently treated of as one or another of the five species. The reasons for this peculiar multiplicity of names are to be found in the wide distribution of the species, the varying food habits of the larva, and the remarkable dimorphism of the imago.

The species was first described as *Tortrix minuta*, by Mr. C. T. Robinson in February, 1869 (Trans. Am. Ent. Soc. Vol. I., p. 276; pl. vi, fig. 49). The specimen from which the description was written had been collected in Texas, by Belfrage.

The following year the insect was redescribed twice,—once by Dr. LeBaron as *Tortrix malivorana* (2d Rep. St. Ent. Ill., pp. 20–23); and again by Dr. Packard as *Tortrix vaccinivorana* (Mass. Agr. Rep., 1870, p. 24). Dr. LeBaron had bred the moth from larvæ feeding upon apple, and published an extended ac-

count of its life history and injuries. Substantially the same article appeared in the "American Naturalist" for June, 1871 (Vol. V., p. 209). Dr. Packard had obtained his specimens from cranberry-feeding larvæ collected in New Jersey.

In the report above cited, Dr. LeBaron states that the larvæ had been very destructive on the grounds of D. B. Wier, Lacon, Ill. At the time of his visit the injury was so apparent that before reaching the place his "attention was arrested by the blasted appearance of the apple nursery, the foliage looking at a distance as if it had been scorched by fire. At this date most of the insects were either pupæ or imagos, the latter being so abundant that a flock of them could be put to flight almost anywhere by brushing against the plants." Dr. LeBaron states that "there are at least two broods of this insect in a season, the first brood of moths appearing early enough to deposit their eggs in the folds of the young leaves just as they begin to open. * * * Another brood was just emerging, as I have above stated, in the third week of July. * * * In what form they pass the winter I believe has not yet been determined."

Of the larval habits Dr. LeBaron writes: "Usually one caterpillar, sometimes two or three, eats off the upper cuticle of the leaf, curling the two sides upwards till the edges nearly or quite meet, and tying them together with web. In this enclosure the little caterpillar goes through its transformations. It lines the opposite sides of the leaf, where the pupa lies, with white silk."

According to Mr. Wier's observations, "The young of the last brood, hatching as they do on the surface of the mature and rigid leaf, do not draw its edges together, but simply protect themselves by constructing a web over the surface of the leaf."*

Concerning the rapidity of increase and possible remedies, Dr. LeBaron writes: "This little insect furnishes a very remarkable example of the sudden appearance and rapid multiplication of noxious species. The moth is so rare that I cannot learn that it has ever before been seen, even by entomologists. If this insect should spread so as to infest other nurseries as it has that of Mr. Wier, it would prove itself a pest of the most serious character; and, so far as we can judge from present appearances, it will be a difficult matter to reach them (the larvæ) with remedial agencies, both on account of the closure of the leaf in which they dwell and their webby covering. * * * Mr. Wier thinks it would have paid him well to have gone through his nursery early in the season and picked off the folded leaves. It is evident that whatever applications we make use of here must be made before the young insects have time to close the leaf above them, in the case of the first brood, or before they have covered themselves with web, in the second. * * * These little worms are so tender and so unprotected by any hairy covering that I should

* It seems probable that Mr. Wier mistook the larvæ of *Pempelia hammondi* for those of the leaf roller, as the latter are not known to have this habit.

expect them to be easily destroyed by any of the ordinary applications, such as lime, ashes, or soap, provided we can find a time when the substance applied will really reach them."

The next notice of the species appears in the "Prairie Farmer" for September 16, 1871, where Dr. LeBaron states that "the observations of the present year give us good reason to believe that this little pest is not going to prove of as serious a character as we at first apprehended. Whether it be that they have been destroyed by natural enemies, or, what seems more probable, in the absence of any known enemies of this kind, that they are very susceptible to the vicissitudes of the weather, it is an evident fact that the hosts of last year have entailed a very scanty progeny upon the present. I visited Mr. Wier's place this season at about the time of my last year's observations, and though there were marks of damage by the early spring brood, the second seemed, for some reason, to have proved abortive. I could find but few specimens, and the nursery trees had made a good growth."

In the "Prairie Farmer" for February 10, 1872, Mr. Wier publishes an abstract of Dr. LeBaron's article and gives the following additional particulars concerning the attacks of the insect: "My attention was first called to it the fall of '63, by a neighboring nurseryman. * * * His acre or more of seedlings could have looked no worse if they had been sprinkled over with dry straw and burned over; yet, as was the case in our nursery, there was scarcely a Tortrix to be seen the succeeding summer, and his seedlings made a very strong growth. I next saw it in my nursery in June, '64, when it swept over a large lot of two year old apple trees but did no serious damage, as there appeared to be but one brood. It was next seen, as stated above, about the 12th of June, 1870, involving the entire apple nursery here, and more or less the orchard. At that time the caterpillars were about half grown, but were not numerous enough to do any serious damage. They commenced to change to chrysalides about the 20th of June, and in three to four days the little bright orange moths were flitting around depositing the eggs for another brood of worms. The eggs soon hatched, and as the brood of worms was at least one hundred times more numerous than the first, the trees soon showed signs of damage. I did not determine positively, but I am quite certain that this brood changed to moths in about thirty days, or the 20th of July, and they at once laid their eggs, increasing perhaps fifty-fold (enemies had begun to prey upon them). They matured about August 20, and laid eggs for another brood about equaling the second; these, so far as I could see, were all killed by frost, that were not destroyed by their natural enemies, when about two thirds grown."

The species is next treated of in the Fourth Report of the State Entomologist of Missouri (pp. 46-48, fig. 22), where the gray winter form is described as "The Green Apple Leaf Tyer—*Tortrix cinderella*, n. sp;" and a short notice of Dr. LeBaron's article

upon *T. malivorana* is given, together with an account of the life history of the latter by Mr. Wier, reprinted from the "Prairie Farmer" for February 10, 1872. Dr. Riley writes: "These worms bear so close a resemblance to each other that it is almost impossible to characterize them." He says concerning the larva of *T. cinderella*: "This worm changes to a chrysalis within the fold of the leaf, lined with silk, and when about to give forth the moth works its way partially out at one end The chrysalis is peculiar from having a rounded projection in front of the head. The moth is a most unassuming little body, with the front wings of a dark ash-gray, without a shade of any other color, the hind wings paler." And of the other supposed species, *T. malivorana*, he remarks: "In habit, and in size, form, and color, it is the exact counterpart of the leaf-tyer just described. The chrysalis is also similar; but the moth, instead of being uniformly ash-gray, is of a bright orange, but of exactly the same size and equally uniform in coloration, so that by imagining a bright, golden orange instead of deep ash-gray, Figure 22, *c* would answer for this species."

In 1875 Zeller again described the orange form of the moth (*Beitr.* p. 6), the species this time receiving the name *Teras variolana*.

In the Report of the U. S. Geological and Geographical Survey for 1876 (pp. 522,523), Dr. Packard publishes the following details of the form on cranberry, which he then called the "Yellow Cranberry Worm (*Tortrix vacciniivorana*):" "The larva draws the leaves together with silken threads, transforming into a pupa within the mass. A single larva seems to select one twig or bunch, and eats the parenchyma from the upper surface of the leaves until every leaf or twig is injured and the plant nearly as much destroyed as if the leaves were eaten up entirely. In this way each larva seems to eat the best part of about twelve leaves, which usually remain on the stalk, affording a shelter to the pupa, which is naked, partly sticking out of the leaves."

Probably Dr. Packard meant that the pupa was thus exposed after the emergence of the moth, rather than before. At least this is the case with the apple-feeding specimens.

Mr. Trouvelot, by whom the drawings for Dr. Packard's illustrations were made, noticed that, like the larvæ of the Hesperidæ, as Eudamus and Tityrus, this cranberry worm sends off the excrement to some distance, when it defecates. When it had built an imperfect cocoon it was very careful to remove the pellets of excrement in it by taking them with the mandibles and carrying them out.

In the "Prairie Farmer" for July 15, 1876, Dr. Cyrus Thomas notes the receipt, from Mr. T. Hallett, Galena, Ill., of a letter stating that a green worm had been doing much injury to the young apple trees, causing them to change color as if singed by fire. In the absence of any specimens the Doctor presumes this to be the present species. Mr. Wier's article, published in the "Prairie Farmer" in 1872 (*l. c.*), is here republished.

In the Report of the Seventh Annual Convention of the New Jersey Cranberry Association (1879, p. 7), Mr. John H. Brakeley gives an account of the injuries of this insect to cranberries, and adds that it is commonly found on the high-bush whortleberry.

There next appears in the Index to the Missouri Entomological Reports (U. S. Ent. Com., Bull. No. 6, pp. 82, 83) a note, following the republished description of *Tortrix cinderella*, in which Dr. Riley says: "From specimens reared from cranberry-feeding larvæ received from Mr. John H. Brakeley, of Bordentown, N. J., I am satisfied that this is the same species briefly characterized by Packard in the first edition of his *Guide* as *Tortrix oxycoccana*, and that *T. malivorana* LeBaron is but a dimorphic orange form subsequently described by Packard as *T. vacciniivorana*. The orange and ash-gray specimens are thus bred both from Apple and Cranberry. I have reared both forms from Cranberry and from Apple, and they are indistinguishable in the larva and pupa states. The gray form is more or less suffused with orange scales and the orange form less frequently with gray scales. This is the most remarkable case of dimorphism with which I am familiar in the family, and points strongly to the important bearing of biological facts on a true classification. The dimorphic coloring is not sexual, but occurs in both sexes. * * * The species belongs to the genus Teras, and, as Packard's specific name *oxycoccana* has priority, the insect should be known as *Teras oxycoccana*, Pack. * * * The gray form of the moth is most frequent in autumn."

Prof. C. H. Fernald, in his "Synonymical Catalogue of the described Tortricidæ of North America," published in 1882 (Trans. Am. Ent. Soc., Vol. X., p. 9), retains the four species—*Teras oxycoccana, cinderella, malivorana*, and *vacciniivorana*,—remarking in a foot note that "Prof. Riley thinks these four species are all one, but surely *oxycoccana*, Pack., must be distinct." *Teras minuta* is also here given as a distinct species, and *T. variolana*, Zell. is mentioned as a synonym of it.

Both forms of the species are treated of by Mr. Wm. Saunders in his treaties on "Insects Injurious to Fruit" under the names given by LeBaron and Riley, but the statement is made that "it is probable that both insects are slightly modified forms of the same species."

In "Papilio" for April, 1884 (p. 71), Prof. Riley, in an article entitled "On the Dimorphism of *Teras oxycoccana*, Pack.," republishes the paragraph above quoted from the Index to the Missouri Reports, and adds that as a consequence of the doubt implied in Prof. Fernald's Catalogue concerning the correctness of these views, he "put the question to so full a test as to leave no reason for doubt. The experience of Mr. J. B. Smith in the field is confirmatory; but from material which he sent to Washington, we not only actually bred the orange form from the first brood of larvæ, received in May and produced from the hibernating slate-

colored form, but also the slate-colored form from larvæ hatched from eggs laid by the orange form. Over two hundred specimens reared from larvæ received in August and produced by the second brood of orange moths were all referable to the slate-colored form. In fact all the moths which issued after September 23 were of this form, though there was but a difference of five days between the issuing of the last yellow and the first gray specimens, the latter continuing to issue through October. Many of the gray specimens, especially those which first appear, are so suffused with orange or reddish scales as to appear somewhat intermediate between the two extremes, but there are none which are not at once referable to the gray form. It is, in fact, an interesting case of seasonal dimorphism."

In Bulletin No. 4 of the Division of Entomology of the U. S. Department of Agriculture (pp. 22–26) Mr. J. B. Smith records a series of observations upon this species as a cranberry insect, describing it as "rather interesting and anomalous in that it has two distinct forms—a gray winter form and a summer yellow form." He states that the moths of the gray form, a few days after emerging," largely lose their red scales, which rub off very easily, and they appear then of a uniform gray slate-color." According to his observations these moths emerge in October, hibernate as adults in "crevices, outhouses, and rubbish heaps," and in the spring (April 15 to May 1) deposit their eggs. About a fortnight later the larvæ hatch and eat the foliage. By May 24 the larvæ had begun to pupate, and the first moths emerged June 4. "These moths were smaller in size than the gray specimens, and entirely different in color, being yellow, with ochreous mottlings. * * * On fresh specimens the ochreous or reddish scales are dense and give the insect a deeper color; worn specimens lack these scales and appear uniformly yellow. The sexes do not differ in size, and none expand more, and many less, than 0.5 inches." The second brood of larvæ appeared late in June or early in July, and the moths produced by them, which are also uniformly yellow, emerge in August, to lay eggs for the third brood, the moths of which, as before stated, emerge in October and are of the gray form. Mr. Smith states that he is perfectly positive that this gray brood is the "result of the eggs laid by the yellow form, for not only were there no gray moths on the bog to produce them, but I watched the yellow forms oviposit, obtained some eggs from females in confinement and sent them to Washington to be reared, and Prof. Riley informs me that gray individuals were obtained from them." He adds that Dr. Brakeley, of New Jersey, had several years before come to the conclusion that the species is dimorphic.

In the issue of the "Canadian Entomologist" for the same month of the same year (April, 1884, p. 64) Prof. Fernald states that he had examined a long series of the specimens bred by Dr. Riley, and was surprised to find that "the orange forms were *Teras minuta* Robs., which was redescribed by Zeller as *Teras variolana*." He adds: "I have for several years past taken a Teras here in con-

siderable numbers, late in September, which I have sent to several correspondents in Europe who have written me that they were quite unlike anything there. These proved to be like the slate-colored and red mixed form mentioned above, except considerably larger; I can see no difference except in size. There is no cranberry growing where these are found, but other related plants, as blueberry, upon which they might have fed. My impression is that they hibernate in the imago state, but of this I am not sure. A few years ago I received several specimens from Mr. G. M. Dodge of Glencoe, Neb., 'bred on wild rose,' which are so like those taken here that I could separate them only by their greater depth of coloring and their much larger size, for they are as much larger than those taken here, as these are larger than those from Prof. Riley and others from Texas. I received *T. minuta* from Mr. Dodge, and also from Mr. Morrison, taken in Nevada, and they also were unusally large. I am, therefore, inclined to believe them all the same species, but I am not yet ready to concede that *oxycoccana* is the same thing. It will be better to allow it to remain separate till it can be proved to be the same, rather than to unite them now, and separate them later, should they prove distinct.

"The synonymy is as follows:

Teras minuta.

Tortrix minuta, Robs., 1869.

Tortrix malivorana, Le Baron, 1870.

Tortrix vacciniivorana, Pack., 1870.

Teras variolana, Zell., 1875.

"The above are the orange forms.

Tortrix cinderella, Riley, 1872.

"Riley's name may be used to indicate the slate-colored form.

Robinson's *T. minuta* was published in February, 1869, and Packard's *T. oxycoccana* not until April, 1869."

The species next attracted attention during 1883 and '84 by its extraordinary abundance in nurseries in McLean county, Illinois. Prof. S. A. Forbes called attention to the outbreak in a paper read before the State Horticultural Society in 1884, (Transactions, p. 124), stating that thick-leaved trees were relatively little affected, but that all the others were so seriously checked in their growth as to excite the serious apprehension of the owner. As to remedies, Prof. Forbes stated that "methods of precaution must be the main reliance," and also recommended that the foliage be sprayed with arsenical mixtures early in the season, when the injury is just beginning.

Similar observations concerning the same attack were published in the Fourteenth Report of the State Entomologist of Illinois.

I recently sent Prof. Fernald a number of both forms of the moth, which had been bred from apple during the last two years, in the hope of determining whether Packard's *oxycoccana* (of which Prof. Fernald possesses the type) is a synonym of *minuta*. But Prof. F. replies (Dec. 27, 1886) that the *cinderella* specimens "do not approach the type of *oxycoccana* any nearer than many others which I have seen, so I am still in doubt about *oxycoccana*."

DESCRIPTION.

Egg.—I have not seen the egg. Dr. Riley in the Index to the Missouri Reports says: "The eggs of this species are very flat, circular, and translucent, with a diameter of 0.7 mm., and are laid singly on the under side of the leaf near the midrib." To this Mr. Smith adds that the egg is "precisely like that of *Anchylopera vacciniana* in form and color, but is very slightly larger." (U. S. Dept. Agr., Div. of Ent., Bull. No. 4, p. 24.)

Larva.—Length 12 mm. Body thickest just in front of the middle, tapering very slightly both ways. Color pale honey-yellow with a slight greenish tinge. Head and prothoracic shield gamboge-yellow; former nearly as wide as latter. Mouth parts darker. Ocelli on a nearly crescent-shaped black spot on either side of head. Another dark spot at base of head laterally, and sometimes a slight trace of a brown line connecting the two, so that the whole resembles somewhat the letter S. Body sparsely furnished with fine pale hairs arising from prominent polished tubercles, the hairs varying in length, the longest being about half as long as the body is wide. The four dorsal tubercles are arranged in a trapezoid, with a deep crease between the anterior and posterior pairs, the tubercles of the posterior pair being farthest apart. Stigmata pale, on middle segments situated slightly posterior to a line connecting the two lateral tubercles and nearest the upper tubercle. Thoracic feet usually tipped with black. Just below tip of dorsal portion of the anal segment and above the anal opening is a nearly vertical plate bearing a series of rows of peculiar blunt bristles, curving slightly upward, those above being shorter than the lower ones, so that the whole forms a stiff brush. (Possibly it is by means of this that the larva is enabled to "send off its excrement to some distance when it defecates," as noted by Mr. Trouvelot in Dr. Packard's article cited above.)

Described from many specimens feeding on apple.

Riley's description of the pupa is as follows:

Pupa.—"Length 0.25–0.30 inch. Brown; characterized by a peculiar rounded projection from front of head; by a little pointed prominence at base of each antenna and each side of penultimate abdominal joint; and by terminating in a broad suppressed piece which produces two decurved hooks. Posterior rim of abdominal joints rasped dorsally, and a slight rasped dorsal ridge near the

anterior edge of larger joints. Legs reaching only to end of wing-sheaths. The head-prominence varies in size and slightly in form." (Fourth Mo. Rep., p. 47.)

Imago.—Prof. C. H. Fernald has kindly furnished me with the following descriptions, drawn up from the large series of specimens from various localities which he has studied:

Orange form.—Expanse of wings, from 14 to 20 mm.

Head, palpi, thorax, and fore wings above, orange-yellow. The fore wings are sprinkled with lead-colored scales which are arranged somewhat in numerous cross lines. The fringes are somewhat lighter in color. The upper side of the hind wings and abdomen are pale fuscous and silky. The fringes and anal tuft are lighter. The under side of the wings and body, as well as the middle and hind legs, are pale yellowish white. The fore legs are orange-yellow in front and pale yellowish-white behind.

Gray form.—Expanse of wings, the same as the orange form.

Head, palpi, thorax, and fore wings above, ashy gray with more or less chestnut-red scales mingled. In some specimens the red predominates; in others, the gray; but they intergrade perfectly, so that no separation can be made. Occasionally a specimen will be found with darker scales arranged in cross lines like those of the orange form. A thoracic tuft with a chestnut-colored tip is occasionally found. The fringes of the fore wings are ashy gray, sometimes stained with reddish. The upper side of the hind wings and abdomen are pale fuscous and silky. The fringes and anal tuft are lighter. The under side of the wings is pale yellowish fuscous, the hinder ones being a little lighter, and with a few brownish sprinkles along the costa and outer margin in some examples. The legs and under side of the body are somewhat darker than the wings.

DISTRIBUTION.

It is evident that this species is widely distributed, as it has been recorded from Maine, New Jersey, Illinois, Missouri, Nevada, and Texas. It also occurs, no doubt, in many other states between and adjacent to those named.

LIFE HISTORY.

The breeding notes of this office confirm the surmise that the life history of the species when affecting apple is similar to that of the cranberry-feeding specimens. Some larvæ collected upon apple stock in McLean county May 15, 1886, commenced pupating about May 22, and by the 27th two thirds of them had pupated. The first moths emerged June 2, and others continued to come forth until June 7. Another lot of larvæ from the same nursery, collected May 21, had mostly pupated, and emerged as moths from the 5th to the 11th of June. In every instance these moths were of the normal summer orange form. Larvæ collected August 6, 1883, on young apple trees in a Marion county nursery, emerged as orange moths on the 20th of the same month.

From larvæ collected on apple in McLean county September 17, 1884, there emerged during October of the same year a lot of slate-colored moths belonging to the form *cinderella* as described by Riley; and March 20 of the present year (1886) I found the same kind of moths (differing from the freshly emerged specimens only in having the reddish scale rubbed off) flying abundantly in the same nursery. Again, from larvæ collected in the Marion county nursery mentioned above September 23 of the present year, the same glistening gray moths have emerged, and are to-day (December 14) alive in the breeding cage. Nor have we ever obtained the gray form in summer or the orange form in autumn.

Although these observations are somewhat isolated and fragmentary I believe that that they are sufficient to establish the fact of the dimorphism and three-broodedness of *Teras minuta* upon apple; and, combined with the observations of other writers, I think they may be said to prove the identity and unity of habit of the three supposed species upon whose life histories observations have been made,—*Teras malivorana* (LeB.), *T. vaccinivorana* (Pack.), and *T. cinderella* (Riley).

Briefly summarizing these various observations, the life history of the species may be outlined as follows: The eggs are laid in spring on the unfolding leaves of apple, cranberry, whortleberry, and possibly other plants, the larvæ soon hatching to devour the tender foliage, of which they form a protective case. Here they continue to feed for about a month, when they pupate within the folded leaves, and about a week later emerge as orange moths. These moths lay eggs for another brood of larvæ, the imagos from which appear in August, being also of the same orange color. These, in turn, lay eggs for a third brood of worms, which develop during September, and emerge during October as glistening reddish gray moths which pass the winter in rubbish heaps, fence corners, and similar places of concealment, and deposit eggs on the unfolding leaves of the various food plants of the larvæ the following spring. Thus is completed this remarkable cycle of insect life—one of the most curious recorded in the literature of entomology.

NATURAL ENEMIES.

In Dr. LeBaron's original article it is stated that Mr. Wier had found a bug preying upon the larvæ, which, from the description given, the Doctor doubtfully identified as *Milyas* [*Harpactor*] *cinctus*.

We have also bred five species of hymenopterous parasites from the lesser leaf roller, all of which are apparently undescribed.* Dr. Riley, who was kind enough to undertake the generic reference of the specimens, writes that they belong to the genera Limneria

*These parasites have since been described by the writer in an article entitled: "On the Parasites of the Lesser Apple leaf Roller, *Teras minuta* Robs.," being Art. III. of Vol. III. of the Bulletin of the Illinois State Laboratory of Natural History.

Pimpla, Cremastus, and Aleiedes, or a closely allied genus. No doubt it is to these friendly insects that the sudden decrease in the numbers of the leaf-roller larvæ so often noticed is to be attributed.

REMEDIES.

It is difficult to prevent the depredations of this insect upon young apple-trees on account of the concealed position of the larva, and its habit of attacking the young terminal leaves. The application of the arsenical poisons is probably as promising as any general remedy; but I believe that the most effective preventive of nursery injury is that of hiring boys to crush the larvæ. This is not such an endless task as would at first appear; and if the first brood of larvæ are thus destroyed, the outlay will be tenfold repaid. That it is eminently practicable on a large scale has been demonstrated the past season by a leading Illinois nurseryman who found that the expense of once going over a badly infested field did not exceed one dollar per acre; and that the outlay was abundantly repaid by the continued vigorous growth of the trees. In a recent letter the gentleman informs me that he intends continuing the practice "more vigorously in the future than in the past."

Mr. Smith has recommended light traps for attracting the moths in cranberry fields; and probably the same means could be employed to lessen the number of the moths in nurseries, especially in early spring, when the hibernating moths are abroad for the purpose of depositing their eggs.

APPENDIX

THE PRESENT CONDITION AND PROSPECTS OF THE CHINCH BUG IN ILLINOIS.*

BY S. A. FORBES.

For three successive years the chinch bug has been extraordinarily destructive in Southern Illinois, gradually extending the area of its investment, until now it occupies there the larger part of thirty counties.

Reports of its occurrence in Iowa, Minnesota, and Wisconsin led us in July to a careful search for it in Northern Illinois; and there also, especially in the counties of Lake, Winnebago, Stephenson, and Lee, it was found locally numerous, and occasionally decidedly injurious to corn and oats adjoining wheat and barley. It has freely bred there this season, in both *winter* and *spring* wheat and in barley; and, as these ripened, has made its way on foot into corn and oats adjoining. From some of the western counties of the State, noticeably from Rock Island county, it is also reported present in great numbers, and injurious to both wheat and corn; while many correspondents throughout Central and Western Illinois have notified me of its appearance in numbers to attract attention and to threaten serious injury in the near future.

The weather conditions in Northern, Southern, and Western Illinois last year, and throughout the State this season, have been eminently favorable to the multiplication of the chinch bug; and if these continue unchanged there is great danger that the larger part of the State may be overrun by it another season. In other words, the agricultural interest of this State is threatened with a loss of possibly fifty million dollars in a single year†—a condition of affairs which clearly constitutes an emergency calling for the use of every resource of knowledge, enterprise, and industry which can be brought to bear; but especially demanding intelligent *joint action* on a *common plan of defense*. While individual farmers

*This article, published in 1887 as a bulletin of the office, is here reprinted for a wider circulation than the original edition of one thousand copies made possible.

†The damage done by this insect to the corn crop alone in Illinois exceeded twenty-two million dollars in 1874, according to the careful calculations made by Dr. Cyrus Thomas. (See 7th Rep. St. Ent. Ill., p. 17.)

may separately protect their crops to a considerable extent, they may by *timely, concerted* action almost completely defend whole neighborhoods at a relatively small expense. Many measures which are useless after an outbreak has reached unmanageable proportions may be quite sufficient to arrest mischief in its beginnings.

NOTES FROM CORRESPONDENTS.

In addition to our personal observations in the field, I have obtained much valuable information from the crop correspondents of the State Department of Agriculture, sent in response to a circular of inquiry issued July 19 to all the counties except those in Southern Illinois well known to me to have been destructively visited this year and last. To these counties no inquiries were addressed.

I find, in brief, collating our information from all sources, that the chinch bug is very destructive in thirty counties; occurs in large numbers in sixteen others; in moderate numbers in seventeen; and in numbers not especially injurious in themselves but sufficient to threaten harm another year in twenty-five; while from thirteen counties it is reported as practically absent.

The following is an abstract of replies received:

ADAMS—A few chinch bugs, but not an alarming number. No damage to growing crops.

BOONE.—A very few, but not enough to do any injury. Will be unsafe to raise either wheat or barley next year.
A few seen when wheat and barley were harvested, but not enough to do any damage.

CARROLL—Nearly destroyed some fields of spring wheat. First brood on the wing a week ago (July 18). Great amount of Hungarian sown here.
No bugs except in the northern part of the county.
Occasional fields have been ruined by them.

CHAMPAIGN—Reported injurious to corn in some fields near Philo.

CHRISTIAN—A few chinch bugs now scattered in corn fields. Not enough to do serious damage, but enough for seed next year.
Not very numerous here. Not hurting anything as yet.

COLES—Chinch bugs have made their appearance in considerable numbers in this locality this season. The first seen here for six years. Have done no material damage and will disappear with plenty of rain.
Oats are being injured by the chinch bug since wheat harvest.

COOK—Some corn damaged by them adjoining rye and barley. A few oats, by the side of rye, killed by them.
At work on barley, rye, and oats, and are commencing on corn. Some corn totally destroyed in patches of one or two acres, and all more or less damaged.

CUMBERLAND—Have been here throughout the year.
All over the county to some extent. Some fields of corn already ruined.

DE KALB—Farmers in northern end of county report noticing them when cutting barley. No damage done to growing corn.

DOUGLAS—Some chinch bugs in corn, but not enough to hurt the growing crop this year.

EDGAR—Very few of them in this locality.

FORD—Noticed in a few localities, but not many in a place.

FULTON—Very few of them. Came recently. No damage done by them here.
Have found a very little sign of them in one or two oat fields only.
Have found a few. Not enough to make any show.
In small numbers in the wheat and oats, and also now among the corn, but not in sufficient numbers to damage the crop.

GALLATIN—Noticed since about the first of June. Thickest where land was poor. One farm was overrun by them.

GREENE—But few in this part of the county. Not enough to do any damage.

HANCOCK—Some bugs here. The weather is very favorable for their increase.

HARDIN—Increasing here very fast. Probably ten times as many as ever before. I think the effect will be felt here this year.

HENRY—The chinch bug has made its appearance, but has not damaged crops to any extent as far as heard from.

Exists in several localities, but has done no serious damage this year. If the winter should be mild, there may be serious results next season.

A few chinch bugs, but have done only a little damage so far. Think the only way to prevent their doing injury is to stop growing wheat and barley.

Chinch bugs here, but doing no damage so far. Cannot tell what the future has in store for us.

JASPER—The drouth and chinch bug have materially injured the growing corn.

JERSEY—The southern part of the county is infested with the chinch bug. They did not come early enough to damage wheat and oats much, but have increased rapidly and are now moving into the corn, where considerable damage is being done.

JO DAVIESS—Spring wheat and barley injured to a small extent by chinch bug. To be found also in oat fields, but not in numbers to do much damage.

Found in small patches in spring wheat and oat fields, doing some damage, but not enough to attract much attention. Also now, in very small numbers, along margins of corn fields adjoining harvested grain.

There are chinch bugs in the corn in numerous fields all about here. A few on the corn stalk under the leaf.

Have been destructive in spring wheat, a little farther south, in both Stephenson and Jo Daviess counties.

KANE—No perceptible damage, although limited numbers have been noticed for three weeks. Last three days have noticed considerable increase in the corn fields.

KANKAKEE—Have heard of only one place in the town where they are in the corn, and there only a little.

KENDALL—Have some bugs in this county, but not enough to do much mischief

KNOX—Damaged winter wheat in some places. Killed some small pieces of spring wheat; hurt oats in some fields; and are now at work on the corn.

LAKE—Have done some damage here in barley.

LA SALLE—A great many are found in places where the corn seems to have fired badly.

Doing great damage to the corn. Made its appearance in winter rye just when it began to ripen, but has done no great amount of damage.

Reported in some localities, but no serious damage done by them. Several of my neighbors found them quite numerous in spring wheat and oats, but now say they can find no perceptible damage. But the bugs are here, ready for another year.

The chinch bug is found in nearly all the corn fields in this part of the county (Seneca). Their presence and the drouth have materially lessened the corn crop.

LEE—A very few have shown in spring wheat, now cut, and in corn adjacent.

LOGAN—None with the exception of a few in oats.

MCDONOUGH—A few chinch bugs on the corn adjoining stubble fields, especially spring wheat. May be laying the foundation for a vast number next year.

MACOUPIN—Pretty well distributed over this county; probably in every corn field. Did not hurt wheat and oats much, but are hurting corn badly.

MADISON—Quite numerous in many fields of corn, which are being severely damaged by them. Grown ones now flying over the country.

Damage has been greater in this county than ever before. Little injury to wheat; considerable to oats. Corn taken clean from the land in many places.

Chinch bugs and dry weather have destroyed over one half our corn crop and part of the oats and wheat. Bugs very numerous; never more so.

Have hardly ever been so numerous before. Damage to wheat at least fifty per cent. in some fields. Took the corn nearly clean as they went. Now nearly all in winged state and making ready for second brood.

MARSHALL—Scarcely any spring wheat raised except in the timber, and there you will find the chinch bug in his glory. After eating up the wheat he goes into the corn. Farmers must stop raising spring wheat; then there will be no bugs.

MASSAC—Been at work here for several years; but little worse now than common.

Are plenty here and have damaged wheat and corn at least one sixth. Ears of corn very short, either on account of bugs or drouth, or both.

Chinch bugs are numerous in this county and in this locality (Metropolis). Have done considerable damage to corn. Many farmers are alarmed for the next year. There is no doubt that they injured the wheat to some extent.

MENARD—Find some, but not enough to do any harm.

MERCER—Damaged some pieces of grain, and have now gone into the corn, but I think not in numbers sufficient to do much harm this year. Prospect of a big lot of them next year.

Doing considerable damage to the corn crop. If the spring wheat had been two weeks later I think it would have been destroyed.

MONROE—Chinch bugs here in force. Damaged the wheat about twenty per cent. Now at work on the corn. Many fields adjoining wheat nearly destroyed.

MONTGOMERY—Have not done much damage yet. Have taken some of the corn adjoining small grain, but are now scattered all over the corn fields.

Southern part of the county has been seriously injured as far north as Hillsboro. Now, at a distance ten miles north of that place, numbers of bugs are found in every corn stalk. We greatly fear that if the present drouth continues the next hatching will be fatal to our corn.

Chinch bugs as numerous as I ever saw them. Materially reduced the yield of wheat in many fields. Oats and corn injured where they grew by the side of wheat, many fields of corn being entirely destroyed.

MORGAN—Made their appearance in this county just before wheat harvest—about the tenth of June. Injured late wheat and barley to some extent, and then went into the corn, but have not damaged it to any great degree.

MOULTRIE—Scattered pretty generally over the country; but not very numerous except in a few places where they went out of wheat and oat fields and injured the corn considerably. If conditions are favorable next year we may expect a full crop of them.

PEORIA—Find but very few.

PIATT—Some bugs in southern part of county, but not in the northern. No damage as yet to corn crop.

PIKE—A few chinch bugs are now at work in corn on sides of fields adjoining oats; to be found by stripping down blades.

POPE—The pest is general over the whole county, but not in quantities sufficient to injure the corn crop except for the drouth.

Bugs very numerous in this locality. Doing considerable damage to corn, some of which is black with bugs.

PULASKI—Has been some complaint of the chinch bug in the neighborhood, but it certainly has not done much harm.

In northern and eastern portions of the county, corn fields adjoining wheat begin to show serious damage, and late corn will certainly be badly hurt. Many farmers burned stubble immediately after harvest and virtually destroyed the bugs

Small strip of county three miles east of Villa Ridge infested, but no great damage is as yet discovered.

ROCK ISLAND—Some bugs in almost every corn field, but not in quantity to do any serious damage.

Spring wheat not materially damaged; but few pieces were taken by the bugs.

Chinch bugs here in multitudes and have done a great deal of damage to wheat and corn.

The ravages of the chinch bug are not general in this part of the county, but wherever wheat and rye were raised it made its appearance early, and as soon as these were harvested it attacked the adjoining corn fields, damaging many acres.

Has made its appearance in some localities, but not in numbers to do small grain very much damage. Corn has suffered very slightly from it.

SALINE—Quite a lot of bugs all over the county.

The chinch bug has injured our corn more than the drouth, and it is multiplying rapidly. Has also killed the crab grass and fox-tail in the wheat stubble of many of our fields.

SANGAMON—Chinch bugs are here, but not in sufficient numbers to excite alarm or even attract attention.

SCHUYLER—A very few chinch bugs in some localities. No damage from them as yet.

Have noticed but very few. Soon after cutting wheat noticed some young ones in the corn. In some localities they damaged oats slightly.

SCOTT—Have heard but one complaint, and this is where the corn field was entirely surrounded by small grain.

SHELBY—Have been damaged but very little in this locality by chinch bugs, though in the southern part of the county they have done considerable harm.

Quite numerous in the wheat fields, and have destroyed corn and oats adjoining wheat and rye. The second generation is hatching.

Went from wheat into corn, and in central and northern townships have done considerable damage.

STARK—In Goshen township the chinch bugs have made their appearance, but little is said as to the amount of damage done

STEPHENSON—In considerable numbers in spring wheat. Plenty to make a full crop by another year.

Were but few chinch bugs in winter wheat, as they came too late for that. They were in spring wheat and barley; mostly confined to timbered districts, there being very few on prairie farms.

Winter wheat is slightly damaged by chinch bugs in this part of the State and spring wheat and barley suffered much.

The chinch bug is so generally present that should next season be favorable for its development, serious harm from them may be expected. They hurt winter wheat nearly or quite as badly as spring wheat. Are now injuring corn, but not to any very great extent. (Hiram Snyder, Lena.)

TAZEWELL—Some in wheat stubble. Not more abundant than usual in corn. No damage so far.

VERMILION—Chinch bugs numerous in many fields, eating fox-tail and millet, but have done no damage to grain. Some farmers report stubble fields swarming with them.

WHITESIDE—About in isolated patches of wheat in small numbers, just to show what they can do

Chinch bugs have made their appearance in quite large numbers in some parts of this county where considerable wheat and barley have been raised, but are not so numerous or general as to cause alarm.

WILL—Chinch bugs are numerous, but yet doing no perceptible damage. Many of them are on the wing. Are said to be numerous in slough grass and wet-land meadows (something unusual), and when the grass is cut they take wing. Have not heard of any damage to corn.

WILLIAMSON—Chinch bugs are all over the county; more numerous than ever before. Killed a good deal of corn when they first went into it, at harvest, and the second brood is now hatching on corn.

WINNEBAGO—We have the chinch bug in great numbers; first in barley, now in corn and oats.

WOODFORD—Find a good many in edges of corn fields, and the weather being so very dry, they will probably injure the crop considerably.
A few here in rye, from which they went to the corn, but not in sufficient numbers to do damage worthy of notice.

Other correspondents from the counties above mentioned reported no chinch bugs apparent in their vicinities, as follows:

From Adams county, 1; Cook, 1; Douglas, 2; Edgar, 1; Ford, 1; Kankakee, 1; Kendall, 1; Knox, 2; Lee, 1; Peoria, 1; Rock Island, 1; Sangamon, 1; Stark, 1; Will, 1.

Those from the following additional counties report no damage in their vicinities:

Bureau, Calhoun, Cass, DeWitt, Iroquois, Livingston, Macon, McHenry, McLean, Mason, Ogle, Putnam, and Warren.

One from Bureau county says: "There has been very little wheat sown here for many years past, and farmers think that this accounts for the absence of the chinch bugs."

Mr. Dougherty, of Otterville, Jersey county, writes that the bugs in his neighborhood are not numerous enough to do serious injury; and that he practices burning stubble to destroy them as much as possible.

Mr. Seeley writes from Oswego, Kendall county, that he has been told by some of the neighbors that a very few chinch bugs have been seen. Has been but little wheat or barley raised there for some time until the last two or three years. Is afraid that if this is continued the chinch bugs will return.

Mr. Samuel Frost, of Macomb, McDonough county, says: "We have no chinch bugs in our county. There is very little spring wheat raised here, which may account for their absence."

Mr. Wm. M. Duffee, San Jose, Mason county, says: "There are no chinch bugs in our fields in this county. We have had none here since we quit raising spring wheat."

Mr. J. H. Anthony writes from West Jersey, Stark county: "Little or no damage done in southwestern Stark. Very little spring wheat or rye raised in this county for several years, consequently the chinch bugs are somewhat held in check."

LIFE HISTORY.

The life history of this insect has been often rehearsed, but will still bear brief repetition.

The chinch bug passes the winter in the adult, winged state (a few black wingless individuals occasionally occurring), under rubbish or around the fields, in corn shocks and straw piles, under boards and among dead leaves in the woods, most abundant, usually, around the edges of fields and in thickets and the borders of woods. From these lurking places, such as survive the winter emerge in April and May (possibly sooner, if the season opens early), and, after pairing, lay their eggs in May and June in fields of spring and winter wheat, barley, rye, oats, and corn—chiefly in wheat and barley,—most of the eggs being deposited in or near the ground on the lower parts of the plants. Many of those hibernating around fields sown to wheat and barley make their way in on foot, thus attacking the outer edges first; but others take wing and scatter freely wherever suitable food invites them. Rarely these winged, hibernating individuals will concentrate in a field of grain in numbers sufficient to damage the young plants at once, even before the eggs are laid; but commonly no marked injury appears until the young of the succeeding generation begin to feed.

By July most of the old, hibernating brood are dead, and the new generation is nearly full grown; far enough advanced by harvest to abandon the fields of wheat and barley for the nearest available food—oats or corn, if these are adjacent, otherwise, and more rarely, grass. Making their way in on foot they will at first attack only the borders of these fields; but later—by the first of August at the farthest—the bugs not already located will begin to fly, and so will become generally disseminated through fields of corn. Not infrequently, especially to the southward, many of the old bugs fly as soon as they get the use of their wings; but as only a small part of them have passed their final moult before small grain ripens, most of the generation must still search for food on foot. In the corn the eggs are laid behind the sheaths of the lower leaves, and under the protection of this retreat the young hatch and mature, only coming out upon the exposed surfaces of the leaves when they become superabundant or when they get their growth. The full grown bugs fly freely, singly, but not in swarms, whenever their food fails them where they are. Rarely we find in the southern part of the State some trace of a third generation in a season, the young of these appearing in September in the corn—but these are in too small numbers to have any practical importance. The generations are thus mainly two; one breeding chiefly in wheat and barley, and the other almost wholly in corn—the adults of this latter brood passing the winter as above described.

Each female is believed to be capable of laying about five hundred eggs.

FOOD PLANTS.

The chinch bug is practically confined for food to the great family of grasses (Gramineæ), which contains all the cereals and grasses, tame and wild. Some of these, however, it feeds upon with reluctance, if at all; and among the ordinary objects of its food it has its very decided preferences. Among the crop plants, wheat, barley and rye, sorghum, broom corn and Indian corn, millet and Hungarian grass are its favorite foods, with oats and timothy clearly second to these; while among the wild grasses, its preference is for fox-tail grass and "tickle grass" (Setaria and Eragrostis). It seems to prefer timothy to blue grass, not really relishing either as a general thing*—and takes to the crab grasses (Panicum) not at all, or only as a last resort. It is reported by old settlers to feed on the wild prairie grasses, and to have bred upon them freely when the country was new; but it is not known what species of these grasses it affects. Nothing seems more precisely to its liking than the Setarias (fox-tail, Hungarian, and millet), unless it be sorghum and broom corn.

*It should be noted, however, that the chinch bug may breed abundantly, with destructive consequences, in timothy meadows and pastures, although in the West this seems not to have been a common occurrence. A limited but severe attack in New York in 1882, was almost wholly confined to these situations.

On the other hand, flax, clover, buckwheat, and all plants in general which do not belong to the family of grasses, remain absolutely uninjured by it, even under the pressure of actual starvation.

PREVENTION AND REMEDY.

There is a general, but mischievous impression among the farmers of this State, especially to the southward, that it is useless to contend against the chinch bug, and that its visitations must be received like those of the drouth and the tornado, as evils beyond our power to prevent or remedy. A careful study of the literature of the subject, several years' observation in the field, and some experiment, have convinced me that this belief often doubles, at least, the calamity of an outbreak, by discouraging at the outset any except sporadic and individual measures of defense.

This discouragement is of course not without its reasons. Commonest, I think, are the following:

1. In this, as in many other cases of insect injury, the number of unreasonable and even preposterous recommendations that have been made have tended to discredit the whole subject of remedial measures.

2. Few are aware of the very considerable number of valuable remedies which have been carefully tried, here and there, with decisive or highly encouraging results.

3. Failures of measures not intelligently or thoroughly applied, or applied under exceptional circumstances, have often led to the conclusion that there was no value in them under any circumstances whatever.

4. Partial or complete failure of the isolated efforts of individuals has sometimes illegitimately discouraged combined action by the farmers of a neighborhood.

5. The use of proper measures in the beginning of an outbreak has been prevented by a failure, elsewhere or previously, of the same measures where the chinch bug had already overwhelmed the country. The best of remedies will fail when the patient is already in the article of death.

6. Failure to accomplish *everything* has sometimes caused abandonment of measures which nevertheless do accomplish *much*.

7. Many reasonable and promising remedies lack the endorsement of accurate experiment, and so fail to command the confidence of the practical farmer.

8. The disposition to speculate on the weather is very common. A hope that heavy rains may intervene to destroy the bugs often prevents action which it is thought may be rendered unnecessary by the turn of events.

I think, however, that all thoughtful men must agree that in the face of so great a danger as now threatens the agriculture of

the State, it is the part of wisdom to take no chances needlessly, but to use every measure of precaution which an intelligent study of the situation can suggest.

In the following summary discussion of remedies I have not usually attempted to discriminate between those which have been tested by general usage or by accurate experiment and those which rest upon theoretical grounds chiefly. I greatly hope that another year may put us in position to try in the field the more important measures of this latter class in a way to bring out clearly their actual value.

The remedial and preventive measures applicable to the chinch bug may be conveniently divided into *agricultural methods*, *barriers against migration*, and *direct destruction*.

A. AGRICULTURAL METHODS.

1. *Clean farming.* The chinch bug seeks in autumn the protection of dead leaves, grass, fallen fence boards, rails, etc., and does not usually fly far in spring if it can find food near by. The farmer, therefore, who harbors the greatest number on his premises will, in the long run and as a general rule, suffer first and worst the following year. Further, some of the commonest grass-like weeds are among the favorite food plants of this insect, and the bugs will be most numerous on farms where these are allowed to grow.

2. *Judiciously diversified farming.* That repeated and general cropping to the cereals alone, especially to only two or three kinds of them, favors the multiplication of the chinch bug, is a fact now so well known as to need no discussion.

3. *Temporary abandonment, in corn districts, of small grain, especially wheat and barley.* This measure of defense, in use for more than a century, is the one most generally relied upon. Its at least partial efficacy is now clearly demonstrated throughout a large part of this State, where the chinch bug is making its advent almost wholly by way of fields of wheat and barley.

It is to be noted, however, that where the number of this insect has risen to great excess, it cannot be reduced again by simply refraining from the culture of wheat and barley. It has been repeatedly shown in Southern Illinois, during the last two years, that under such circumstances the bugs will breed as freely and successfully in oats as in other grains; while recent occurrences in New York prove that the meadow grasses afford them almost equal opportunity. This is consequently a preventive rather than a remedial measure.

A serious error is prevalent in some parts of the State with respect to the relation of the chinch bug to winter wheat, many believing that this insect cannot flourish on winter grains. The fact is, however, that the tremendous attacks under which South-

ern Illinois has suffered for the last three years, have been delivered first, each year, upon the fields of winter wheat, no spring grain but oats being raised in that entire region; and our recent observations in Northern Illinois, where winter wheat has lately been introduced again to some extent, show that there likewise this has suffered scarcely less, in several instances, than spring wheat beside it. It is probable, however, that where both varieties are raised, the spring wheat will usually be worst attacked; but certainly if only winter wheat is grown, this will afford every necessary opportunity for the multiplication of the chinch bug.

4. *The temporary abandonment of corn in regions where small grains are the principal crop.* This expedient was suggested by observations made in the wheat regions of Washington county, where nature made for us, in 1886, an experiment on a large scale, showing the result of a lack of food for the midsummer brood of the chinch bug. The few corn fields in that region being early destroyed by insects and drouth, the breeding of the bugs was cut short in the corn, and the adults were forced to desert the fields in midsummer. Most of them consequently flew to the woods and lived principally, during the remainder of the season, upon certain woodland grasses. The number of the hibernating generation was thus cut down, and those surviving passed the winter almost wholly in the woodlands, with the consequence that fields at some distance from woods were nearly or quite free from attack the following spring. A general burning of the woods and thickets at the proper season, as recommended under another head, would probably have almost wholly protected this entire region.

5. *Culture of crops not affected by the chinch bug.* The most important of these are clover, buckwheat, potatoes, turnips, and the root crops generally; flax, hemp, beans, castor beans, melons, strawberries, and all the fruits. Oats and the common meadow grasses are usually less damaged than wheat, rye, barley, Hungarian, and millet.

6. *Heavy fertilization,* both of the ground before planting, and of the surface where the crop is attacked. This method takes effect both by supporting the plant under the drain of insect injury, and by causing a more luxuriant and thicker growth of vegetation, which shades the ground and renders it moist, thus supplying conditions unfavorable to the multiplication of the chinch bug. It is, by many, supposed that the bugs prefer an unthrifty vegetation to one in vigorous growth, but this is certainly not invariably the case. Fields of corn, side by side, one fertilized and the other not, are often equally infested by this insect, the conspicuous difference in condition being due wholly to the greater resisting power of the stimulated plants. This practice has likewise the advantage of forcing the development of the crop, thus pushing it out of the way of early injury.

An experiment recently conducted for me by Mr. Samuel Bartley, of Edgewood, bears on the utility of this method. A plot of

wheat heavily fertilized before sowing, with barn-yard manure—almost the only wheat in that neighborhood—was very vigorously attacked in spring by the chinch bug, much of it being badly damaged by the adults of the hibernating generation before they had even laid their eggs. Nothwithstanding this injury, and that by the much more abundant generation following, this plot yielded, according to a report made to me August 4, at the rate of 20.8 bushels per acre, 54 pounds to the bushel; while the portion of it treated in spring with special fertilizers* yielded at the rate of 24 bushels per acre, 62 pounds to the bushel. The ususal average yield of this region does not exceed 18 bushels. It is scarcely possible that this field could have yielded more than ten bushels per acre if left unfertilized. The effect of the first application of manure was, therefore, to about double the crop; and that of the second, to further increase this yield by some twenty-eight per cent.

7. *Fall plowing, and heavy rolling after the seed is sown.* This measure is based upon the fact that the female chinch bug seeks the roots of grain in spring upon which to lay her eggs, and can penetrate compact soil less readily than that recently plowed. As the eggs are very frequently and freely laid, however, upon the lower part of the plant above the earth, this measure probably cannot have any very important effect.

8. *The use of surplus seed.* This serves a double purpose; that of shading the ground, as mentioned above, and that of supplying an excess of vegetation, some of which may be sacrificed to the bugs without serious diminution of the yield.

9. *Early planting of crops exposed to chinch-bug attack (excepting corn).* As the principal damage is done by the young of the spring generation, and as these do not ordinarily begin to hatch until the middle of May and are most destructive late in June, early planting may often so advance the crop as to get it practically out of their way. This applies as well, of course, to winter grain as to the spring varieties.

10. *Late planting of corn.* Corn should be planted late enough to make it certain that the hibernating adults have all left their winter quarters and established themselves in grain fields for reproduction; otherwise the crop may be infested by this first generation as well as by the second.

11. *Mixture of seed, to repel or destroy the insect.* The sowing of clover in spring on winter wheat is largely practiced in Southern Illinois, and with unquestionably good effect, provided that the clover grows freely enough to shade the ground by the time the young chinch bug gets fairly under way. Frequently, however, in that latitude, clover makes too slow and slight a start to effect this purpose.

*One hundred pounds each, per acre, of nitrate of soda, superphosphates, and sulphate of potash.

Timothy may often be sowed in fall, to the best advantage, with winter wheat or rye, as reported to me by Mr. John A. Kelly,* of Cumberland county, in a letter dated June 25, 1887; and also more at length by Mr. E. E. Chester, of Champaign county. Mr. Chester's experience demonstrates so precisely the very great value of this method as a protection to the wheat crop under the most unfavorable circumstances possible, that I will report it in full.

A field of twenty-eight acres was sown to wheat in the fall of 1874, when the chinch bugs were innumerable throughout all this region—twenty acres with timothy and the remaining eight without, timothy being sown on the latter in the spring. This eight-acre plot, like the rest in every respect except that mentioned, was overwhelmingly infested by the chinch bug, the grain at harvest yielding only seven bushels per acre, while the twenty acres, bearing a thrifty growth of fall timothy, remained wholly unaffected except for a short distance adjoining the other plot, and yielded an average of twenty bushels to the acre. The latter wheat sold as "No. 1," at one dollar per bushel, and the former as "rejected," at sixty-five cents.

Winter rye is sometimes sowed with spring wheat, for similar reasons.

Flax has also been sowed, with good result, on both spring and winter wheat, being itself exempt from attack and serving to shade the ground to a considerable extent. According to some observers, it even repels the bugs.

The sowing of buckwheat and flax in the outer rows of fields of corn is likewise reported to have protected them from invasion.

12. *Strips of favorite food plants sowed as lures*: millet or Hungarian around wheat or corn; spring wheat around winter wheat or oats; sorghum or Hungarian around corn or between the outer rows. The object of this procedure is to induce the adults escaping from wheat fields or emerging from their winter quarters, to lay their eggs in these special strips, which are then plowed up and planted to other crops, thus destroying the unhatched eggs and the young.

13. *Sowing strips of favorite food plants near the winter quarters of the bugs.* When woodlands and thickets contain numbers of hibernating insects, these may be thus tempted to deposit their eggs, which may then be destroyed early with the vegetation used as a lure, the ground being afterwards replanted to some crop not affected by the chinch bug.

14. *Sowing strips of plants not injured by chinch bugs, as barriers to the migration of the spring generation.* These should be interposed especially between fields of barley or wheat and

*"I have accidentally discovered that by sowing timothy with the wheat in the fall, if I get a good catch the bugs cannot breed, as the wheat starts first in spring and then the grass forms a dense shade by the tenth of May. When the bugs deposit their eggs they cannot hatch on account of too much shade."

oats or corn. Their effect will be only to delay and distribute the migration of the brood, possibly resulting also in the starvation of the younger individuals.

15. *Encouraging spring growth of volunteer grain* on ground to be used for corn, or other late-planted crop. Late spring plowing of this ground preparatory to planting will destroy the eggs and young with which it will probably be stocked.

16. *Irrigation of the infested fields*, where it is possible, is, of course, a complete remedy.

B. BARRIERS AGAINST MIGRATION.

1. *Planting strips with crops not subject to injury by the chinch bug*, as described above under No. 14. This, to prevent the speedy migration of insects of the spring generation from fields of wheat and oats at harvest.

2. *Plowing and harrowing at harvest time around infested fields*, for a similar purpose.

3. *Plowing one or two deep furrows around the field.* "The earth should be thrown away from the protected field, and the furrow not allowed to settle or harden, but be kept friable or dusty by dragging a log or stone or a bundle of brush along it each morning. The philosophy of the plan is that the bugs cannot climb up the loose surface, especially on the perpendicular side. The dragging each morning will kill many, but they should be either trapped or destroyed in pits, or burned by strewing straw each morning on the invading side of the furrow, and burning the same each evening, when a chinch-bug holocaust will result." —Riley.

4. *Pouring coal tar along the ground* just outside the borders of infested fields, as recommended by Dr. LeBaron in his second report. "This method," he says, "has been extensively resorted to the past season (1871) in the central part of the State. I had an opportunity of seeing it put in practice, on a large scale, on the farm of Mr. Joshua Sells, of Bloomington. At the time of my visit, Mr. Sells had adopted the plan of running a stream of tar from the spout of an old tea-kettle directly upon the ground, along the exposed sides of his corn fields. He found that a gallon of tar would extend about ten rods, so that a two-gallon kettle, twice filled, would furnish a strip of tarred ground the whole length of a forty-rod corn field. The tar had to be renewed every other day, and oftener in case of rain. The insects would crowd up to the line in such numbers that in many places they would pile up from half an inch to an inch deep, and could be scraped up by the double handful. But so long as the tar was kept fresh, not a bug would cross it. They were not prevented from crossing by the adhesive nature of the tar, but by its repulsiveness. The bugs would not touch it. They were destroyed by conducting them into perpendicular holes, or by shoveling them in and burying them."

C. DIRECT DESTRUCTION.

1. *Destroying the bugs by fire in their winter quarters in fall and spring.* After the first frost in autumn, and before the warm invigorating weather of a well-established spring, the bugs are all concealed under rubbish—most abundant usually around headlands, under corn stalks, etc., and often, also, among the dead leaves in the borders of woods. Here vast numbers of the bugs may be destroyed by burning (especially where wire fences make this process comparatively easy), and every one of these winter residents killed may mean a hundred thousand less in the fields the following summer. While this measure will often pay the individual farmer as a protection of his own crops alone (since these are usually first and worst damaged by the bugs harbored on his own grounds), yet the full measure of possible benefit can only be obtained by general action by the farmers of a neighborhood. Burning will be more effective in fall than in spring, because the bugs not destroyed by fire will be exposed to the winter weather by the destruction of their shelter. It is necessary that the burning should be done when the grass and rubbish are thoroughly dry, otherwise the fire may run lightly over it without destroying the insects.

2. *Distributing straw, corn stalks, etc., as lures to hibernation, and then burning.* By offering inviting winter quarters in and around infested fields, the adults may be readily collected where they can be conveniently and completely destroyed.

3. *Spreading straw and rubbish around ripening grain fields and burning at night.* Chinch bugs leaving a field are disposed to shelter themselves at night, and are thus exposed to destruction by this method.

4. Similar protection may be afforded to corn fields subject to invasion.

5. *Plowing up killed grain and planting to other crops.* Nearly all the younger bugs will find it impossible to escape from a plowed field, and will perish by starvation.

6. *Plowing under deep, or killing by burning over the ground where grain has been destroyed.* Sometimes a light covering of straw will be necessary for this latter purpose.

7. *Plowing under the outer rows of corn,* where these have been invaded from adjacent fields of grain.

8. *The application of insecticides:* gas lime to wheat and corn; the kerosene emulsion to corn, possibly, also, to wheat in early spring; hot water and soap suds to infested stalks of corn.

As farm help is relatively abundant after harvest, applications of inexpensive insecticides may sometimes be made with profit, especially if their use upon a few of the outer rows of corn shall have the effect to protect the entire field. A simple mechanical mixture of water and three per cent. of kerosene is deadly to chinch bugs

of all ages, and does not injure half-grown corn if the fluid is thoroughly and repeatedly shaken up. Or, as a safer application, an emulsion of kerosene may be made with a soap suds containing one pound of soap to twenty gallons of water. Two gallons of kerosene oil should be boiled with a gallon of suds, and then, while hot, thoroughly churned or mixed with a syringe or hand-force pump until a permanent cream or butter is produced. This emulsion may be diluted with the soap suds at the rate of a gallon of the former to fifteen or twenty gallons of the latter.

9. *The application of repellent substances,* to prevent the chinch bugs from laying their eggs upon the crops; a measure suggested only as worthy of experiment. A light coating of partly stale gas lime, not too freely applied to wheat in spring, or placed by the handful at the roots of corn at harvest, might possibly protect these crops.

10. Finally, *the artificial cultivation of the germs of the contagious diseases* of the chinch bug, with a view to spreading these diseases at will by means of such artificial cultures. This is a theoretical remedy only, and much additional study and experiment will be required to put it on a practical basis.

SPECIAL PROCEDURE RECOMMENDED.

For those parts of the State not already practically mastered by the chinch bug, especially for Northern and Western Illinois, I would earnestly recommend the following procedure for the coming fall and spring:

1. Give up wheat, rye, barley, Hungarian, and millet, for the coming year; or,

2. If the just mentioned *grains* are grown, sow with them timothy this fall, or clover next spring.

3. Pick up boards, rails, and sticks along roadsides and around headlands this fall, and thoroughly burn over the borders of the fields and similar places, thickets, woodlands, etc., late this fall if practicable, selecting for this dry days when rubbish will burn close to the ground. Such places as cannot be burned in fall should be fired early in spring.

4. Fertilize ground to be used next year for small grain or corn, and apply to the surface next spring quickly acting fertilizers, where crops become infested.

5. Plant all the crops, except corn, at the earliest time permissible.

6. Search carefully for the bugs next spring in their usual quarters, as a means of determining the possibility of serious injury; and, if this seems threatening,

7. Raise extensively, another year, crops not affected by the chinch bug.

8. Do these things, not singly and imperfectly, but thoroughly and by neighborhoods; by mutual consultation and organized co-operation; and there is excellent reason to believe that the chinch-bug outbreak now impending may be suppressed, or at least kept down, until a favorable change in the weather for a season or two shall make artificial measures unnecessary.

It is important to repeat, as related to the possibility of *local protection*, that our observations of recent years show that the chinch bug does not ordinarily travel far, but that the damage in any region is done almost wholly by the bugs bred on that ground.

FIELD EXPERIMENTS PROPOSED.

I am painfully aware that many of the recommendations made in this paper rest upon no basis of accurate experiment, leading to precise, demonstrated results. I ardently hope that, if the chinch bug prevails another year, we may be in position to make such experiments in the field in different parts of the State; but to that end I have to ask the co-operation of the farmers interested. I consequently especially request correspondence with those who are disposed to afford us an *opportunity for trial*, upon their grounds, of the most important and promising measures against the chinch bug. Such experiments will be conducted personally by myself or my assistants; but for the privilege of making them we must look to others.

It will be necessary, in most cases, that small selected plots of uniform character be placed at our disposal; that some of these be treated experimentally and others beside them left without such treatment, as a check upon the results; that the product of all be kept perfectly distinct, both at harvest and threshing; and that it be accurately measured and weighed. The subjects of special interest from this point of view are the following: (1) general and special fertilization; (2) the use of surplus seed; (3) the sowing of mixed seed—clover, flax, timothy, etc., with the small grains; (4) the sowing of strips as lures to oviposition; (5) the planting of strips as barriers; (6) the use of coal tar as a barrier against migration; (7)the effect of burning over the winter quarters of the bugs; (8) the use of straw, corn stalks, etc., as lures to hibernation; (9) the effect of plowing under the outer rows of infested corn; (10) the application of insecticides or repellents—especially gas lime.

With positive and precise knowledge of the value of these measures under varying circumstances, an important advance will certainly have been made in our practical acquaintance with this arch-enemy of western agriculture.

ERRATA.

Page 8, line 22 from bottom, after June insert 1886.

Page 69, line 10, for fruit read fruits.

Page 75, line 8 from bottom, for I. read II.

Page 84, line 6, for scale read scales.

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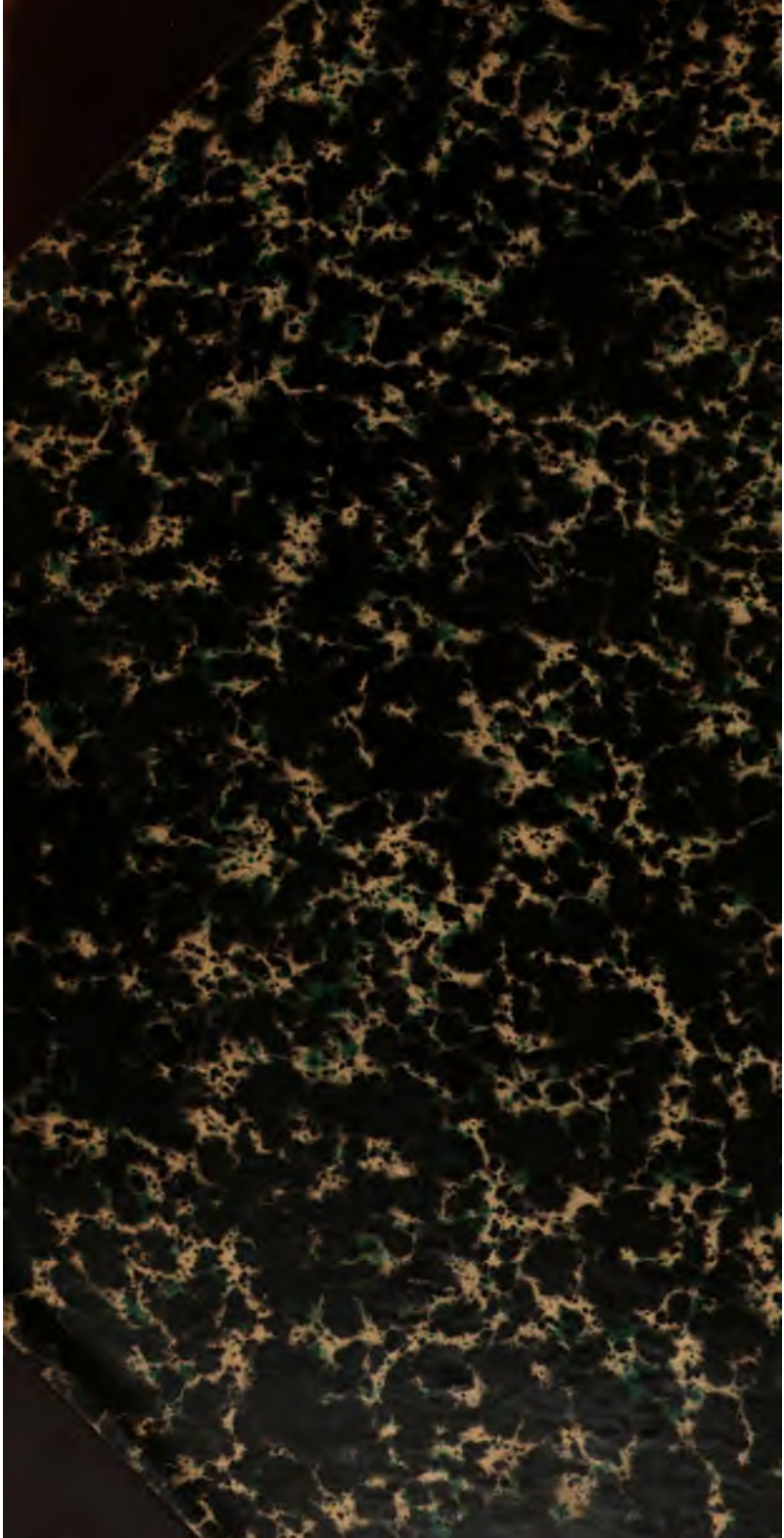
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